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THE NATION AND ITS WATER RESOURCES

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Public Health Service
Portland, Oregon

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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These notes, titled The Nation and Its Water Resources, are part of a larger study on the role of the several levels of government, which form our federal system, in water resource conservation, development, and use.

Part I, reproduced here, is essentially a broadly based historical review of the inter-relationships between water and the growing nation since colonial days.

This material has been reproduced for limited distribution to personnel of the U. S. Public Health Service, Division of Water Supply and Pollution Control, for such aid as it may furnish in connection with their water resource planning activities.

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May, 1962; Portland, Oregon

INTRODUCTION

The Nation's strength is rooted in its capacity to change to meet emerging problems. Such change, if it is to be for the better, places heavy responsibility on the Nation's leaders--Federal, State and local--and requires of them intimate knowledge of the processes of government. It also requires a knowledge of what we are changing from as well as what we may be moving toward.

The problems associated with the management of the Nation's water resources are not unlike most of the problems of a functional nature confronting the Nation. The problems are responsive to varying conditions existing at any given time. In the past, changes in the water field have been related to needs for navigation, drainage, municipal water supply, power, irrigation and others. Most often these have come about on the basis of individual needs or in terms of local demands.

As the Nation grew, water problems also grew, now often combined and representing larger areal requirements. Growing problems resulted in multiplication of governmental and private agencies having some responsibility and concern for the conservation, development and use of the Nation's water resources. Today, this responsibility is widely shared between Federal, State and local governments; private organizations and individual citizens; a typical example of our Federal system in the twentieth century.

The methods by which the Federal system identifies problems, develops plans, assigns responsibility, executes works, appraises results and repeats the process have been appropriate subjects of study since the De Toucevilles and Bryces. The workability and continued success of the system has been and remains largely dependent on a wide understanding of the processes involved by the citizenry and officials generally and by the degree of expert understanding by public and private persons directly concerned with the management of the particular subject matter. The process is continuous, applicable to every generation.

There is, in addition, a larger and perhaps more critical need for this form of continual self-evaluation than merely the improved operation of our governmental form. Cold war competition, the conflict of differing systems played before an international audience, has national survival at stake. While expert knowledge of our system, prior to 1946, had as its principal aim self-improvement, today such knowledge is essential if the Nation is to meet this ultimate test.

Whether our relatively loose Federal scheme and related personal freedom has the toughness to survive in competition with the iron discipline and closely directed resource development and utilization programs of the Communist world is largely dependent on first, how well responsible people in every segment of government and in the private sector of our society understand the challenge before the Nation and secondly, on how well we understand our own actions and how effectively we apply adjustments deemed advisable to strengthen our processes.

While, desirably, the basis for change should preferrably result from our own evaluation of current needs, the practical effect of competition from opposing forms of government in forcing a reappraisal is being felt, and, in fact, seems to be the driving stimulus in American life today. Thus, we have increasing need to be keenly aware of the intimate workings of our society if we are intelligently to compare ourselves with others and to reap, possibly, resulting benefits. While this study is concerned with water, and primarily with organizations responsible for placing this resource at the disposal of man, it also represents a study, in microcosm, of the general way in which decisions are made relating to many of our resources.

The planning task, comprising the identification of problems, the studies leading to the establishment of solutions within the purview of public policy and the appraisal of results is an essential part of the task of transferring the potential values in water resources to actual values--to man's use.

In our Federal scheme, planning is a responsibility of all segments of our society. Consciously or unconsciously, decisions are made daily, which when added together, become our local, State, regional and national policy. In more even-tempered times, our Nation with its adequate wealth has been able to proceed unhurried in planning and executing its water resource developments. Today, the swelling demands of people, industry and agriculture are forcing an accelerated pace within our own consciousness. Foreign policy involvements compound the situation in that the competition is forcing us to give adequate illustration that our system can not only develop resources expeditiously, but maintain political and economic freedom of its citizens while doing so.

This study represents a phase of the continuous effort to sharpen our understanding of how the Federal system operates; in this case with respect to the water resource situation. Broadly, the aim of the study is to present a view of the Nation's political institutions, including the private sector, responsible for the development and control of its water resources. The means selected to do this is through an examination of the six broad types of organizations having responsibility for the management of this important resource. The types are Federal, State, Interstate, Municipal, and Local non-municipal and private. It is hoped that a clear definition of the role of each major type will contribute to improved coordination and relations within and between types, reduce overlaps and conflicts, bring about a better understanding of how responsibility is shared and as a result contribute to improved water resource management and the coordination thereof at every level of government. It is also hoped that the study will make it possible for every affected citizen and official to identify himself with the segment of the total to which he belongs, to view his position and the position of his organization in terms of every other organization in the field, and to gain a sense of the total task that lies before the entire Nation. Finally, the study would hope to suggest improvements in these aspects of resource development as a result of this examination.

The study has been developed in two parts. Part I is primarily an historical review of water resource development and water use in the United States since colonial days. In this review, an effort has been made to show the relationships between water and the social, economic and political characteristics of the several time periods. Part I has its principal value in providing a viewpoint about changing conditions occurring during the Nation's growth, the demands imposed on the water resource as a result of such changes, and the responding effect of society to these demands.

Part II leads to the development of conclusions, using the assessment of our past history in Part I, together with a statement and evaluation of present day problems and conflicts, which suggest how the nation, through its component (or type) water organizations can best meet the problems of the future.

PART I - A

THE NATION AND ITS WATER RESOURCES

CHAPTER I

THE WATERWAYS--ATLANTIC TO PACIFIC

In beautiful prose, Rachel Carson (1) describes life arising out of the early seas. As man returns to stand on the edge of mother sea, "...he knows the truth that his world is a water world, a planet dominated by its covering mantle of ocean, in which the continents are but transient intrusions of land above the circle of the all-encircling sea."

We need not stop on the edge of the sea. The "water world concept extends onto the continents and into the atmosphere within which we swim. The development of the Nation is a trail along water paths, it was "over the water" for the first settlers, it was in the water that they found sustenance, or through plants and animals to whom water is mother as well. It was on tidewater that first homes were established. Stream valleys led the way into the interior and settlements built on river banks. Furs, agricultural products and industry moved and grew on water shores. Moving away from the flowing stream, dependence was placed on water from the atmosphere and, at a later date, sought deep in the ground into which it had soaked. For the courageous moving West, water barrels hung on covered wagons kept the tie to the sea as did the canteen for the lonely prospector. For mortal man, his lifeline stretches to the sea wherever his journey takes him, even into space.

The history of the exploration of the Americas is woven about its waterways.[1] This is not unique, for rivers have been arteries of travel from earliest times. The mystic aspect of the searches in the western hemisphere is to be found in the seeking of the water route, later the Northwest Passage, to the riches of Cathay and the Indies.

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[1] Rarely, if ever, has history marked out the importance of waterways so clearly as in the mid-continent area of North America. This history has extended over four and one-half centuries, and it seemed a useful beginning to open Part I of this study by recounting briefly the salient aspects of the part played by these waters. In developing Chapter I, heavy reliance has been placed on Course of an Empire by Bernard A. De Voto (2); the Works of Francis Parkman (3); and The Journals of Lewis and Clark, edited by Bernard A. De Voto.

The urge for gold led the Spanish, eyes blinded to the realities of the vast new country by Pizarro's successes, to initiate a delineation of regions determined by the major water routes. This process, completed nearly three centuries later in Mr. Jefferson's purchase of the Louisiana Territory, formed the continental expanse of the United States.

Thirty-five years after Columbus' first voyage, Panfilo de Narvaez with four hundred men and eighty horses, reminiscent of Cortes in Mexico, wandered aimlessly across the swamps and river mouths from Tampa Bay to the Apalachicola River in West Florida. In 1539, twelve years later, Hernando De Soto followed Narvaez into Tampa Bay. During 1540, he led his band across Georgia into the Eastern Carolinas and the Tennessee Valley. He found and crossed the Mississippi River, in Northern Mississippi, in 1541 and subsequently touched the Arkansas River, the Northern Ozarks and returned to the Mississippi near Natchez to die in 1542. His Lieutenant Luis de Moscoso marched west across the Red River and Sabine, nearly reaching the Trinity River. Only a narrow gap remained to keep the Spaniards from ringing the Southern approaches to the Mid-North American continents. Coronado, in 1541, had reached up through the Southern entrance, crossed the headwaters of the Rio Grande, the Red and the Canadian Rivers, and had marked out for history the fabled country of Quivira (Kansas) north of the Arkansas. Less than three hundred miles separated him from De Soto in the East.

In the West, the ring was closed. To Hernando de Alarcon was given the task of supporting on waters, the main land explorations of Coronado. With three vessels, he sailed north into the Gulf of California and saw the mouth of the Colorado River a year before De Soto saw the Mississippi. Melchior Diaz, commanding the fourth and western arm of Coronado's forces, moved to the Colorado where he found messages from Alarcon's ships.

The land and sea routes once joined opened the door and the Spaniards slowly pushed into the new country from the South and West. In the East and South, however, disaster and the lack of fortune kept the region in darkness for one hundred and forty-two years until La Salle's voyages in 1684 caused Spain to take another look at the land of De Soto's death.

North of Quivera, Coronado had heard, was a great river running to the North and West. Rumors and desk geographers postulated its headwaters in a Western Cordillera in the unknown interior. A hundred and thirty years was to pass, however, until Father Marquette and Louis Joliet saw the mouth of the Missouri in June, 1673.

While the Spanish probed for treasure and the spice islands in the South, a Frenchman in the North added another key feature to geographic knowledge. Four years before De Soto started his journey to the Mississippi, Jacques Cartier sailed into the Great River of Canada, later to be known as the St. Lawrence. In lieu of golden treasures, he found a society ready to offer fur for manufactured goods.

Moreover, from its members he heard of great seas of fresh water to the West. From Cartier in 1535 to Samuel de Champlain in 1603 Frenchmen developed trade and took out the products of the new world equal to metal treasure. The effective trade combined with missionary zeal drove Frenchmen west through the great system of the St. Lawrence until by 1634 New France extended west to the 88th Meridian on the west shores of Lake Michigan.

Founding Quebec in 1608, Champlain moved farup the Ottawa River while an advance party reached Lake Huron. The main highway followed the traditional Indian route; Ottawa to Mattawa River, up to Lake Nipissing and down French River to Georgian Bay and the Great Lakes. Etienne Brule, in 1623, touched the hub of the Indian world, the Sault, between Lakes Huron and Superior, and eleven years later, in 1634, another of Champlain's young men, Jean Nicolet, traversed South through the Straits of Mackinac and Lake Michigan to Green Bay and the Fox River.

To close the gap with De Soto and to confirm Coronado's vision of the great river beyond Quivera required another forty years. Forerunners of the new breed of Frenchmen; voyageurs, trappers and traders; Medard Chouart, Sieur des Groseilliers and Pierre Esprit Radisson, in 1654, traced Nicolet's path to Green Bay. They extended knowledge of the country by traversing the entire length of Lake Michigan and, from notes, some believe it probable that they reached the Mississippi. They, too, heard of the forked river, one branch of which ran South (into Mexico), the other into the West (the Missouri). They also heard of Hudson Bay, far to the North of Lake Superior, reached through rivers which ran north, and by 1660 chartered a trading plan which would bring the French into conflict with the English at Hudson Bay and lay the basis for a hundred years of war.

From 1660 to 1670, Jesuit Missions extended into the new territory, with establishments at the Sault and Green Bay. By 1673, Marquette and Joliet were ready to start the great expedition to explore the Mississippi, knowledge of which had been reported without question by the Indians. In May with five voyageurs and two canoes, they left the Mission of St. Ignace, travelled south on Lake Michigan to Green Bay, crossed the divide of the Fox into the Wisconsin and reached the Mississippi June 17. Joliet calculated the latitude to within one-half degree. By the end of June, travelling southward they encountered the mud laden flood waters of the Pekistanoui (Missouri). Moving further South, they passed the Ohio, finally stopping about where De Soto made his crossing a hundred thirty years before.

It remained, however, for La Salle to understand the meaning of the crossing paths of De Soto with Marquette and Joliet, and to outline the main lines of future French strategy. He recognized the Mississippi as the key to control of the vast continental heartland. The English had been bracketed into the East. The West would stay available for later exploration. Between 1673 and 1689 he opened a third water route from the St. Lawrence, through the Niagara and the Great Lakes and across the Chicago portage to the Mississippi. He founded forts on the St. Joseph, in Michigan, and on the Illinois. St. Louis at the mouth of the gateway river to the West became headquarters for France's imperial dreams in North Louisiana, and the Ohio became the line beyond which they would attempt to bar the English for nearly a hundred years. And some forty years after La Salle's Mississippi was claimed by the British, Lewis and Clark started their journey up the Missouri which was ultimately to claim most of the western continent for the new Nation.

Classic of western rivers, the Platte--broad, shallow, multi-channelled--with its strong underground flow belying the appearance of its low summer flow, was the dividing line between the two nations. The second main Spanish expedition in 1594 reached the Arkansas and the Platte Rivers. The colonizer of New Mexico, Juan de Onata reached Wichita on the Arkansas in 1604 and touched again on Spanish trails on the Pecos, the Canadian, the Cimmaron. However, it was not until 1761 that the Spaniards again came near to touching the Platte in its mountain headwaters. The main Spanish trail led off to the West into the California coastlands and valleys with Father Junipero Serra opening his first Mission in 1769 and establishing Monterey in 1770.

Etienne de Bourgmend, from 1712, was moving up the Missouri to the Platte and touching the Kaw of Northern Kansas. While the French moved to the West in the North, the Spanish crossed to East in the South, and their lines of travel remained uncrossed in the vastness of the great plains.

The main stream of French development, apart from the Mississippi, continued to extend toward the west through the multiple waterway routes from the trade and government centers of Quebec and Montreal. The next step in the chain of search found Pierre Gualtier de Varennes, Sieur de La Verendrye moving, in 1728, from his trading post at Lake Nipigan north of Lake Superior through the Northern Minnesota lakes north and west to Lake Winnipeg. He, too, heard of the Great River of the West, and during the next ten years he continued to move into the West. Eventually, in 1738, he extended his trade area travelling the Red of the North and then overland to the country of the Mandans at the Great Bend of the Missouri in North Dakota. Here Verendrye's sons, Louis-Joseph and Francois, the last of the line of Champlain, made the last French effort to reach the Pacific through the Missouri. In 1743, they moved through the Western Dakotas and saw the Black Hills which they believed to be the western mountains.

From 1753 to 1760, the goal of seeking new wealth had to be put aside for the struggle to exist. With the fall of Quebec, French North America, except Louisiana, shifted to English rule. Spain, new controller of the Mississippi Valley, took no significant action to strengthen or extend her southwestern provinces into the East.

Highly sensitive to the more subtle but real effects of the land and waters on human aspirations, Bernard De Voto[1] has the new Continent ask, "Are there geographical units here to which political units must correspond?" Important answers to this question provided during the thirty years following 1780 were to mark out the continental boundaries of the United States with a fine symmetry and inter-relationship to nature that was to yield untold strength to the new Nation.

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[1] Bernard A. De Voto, The Course of Empire (Boston: Houghton Mifflin Company, 1952), p. 228.

Whatever the reason the fact remains that the English, following close on the completion of the Revolutionary War, proceeded to make vast strides west to the Pacific, and north by sail up the Pacific Coast, but laid no claim that could be upheld within the present United States borders.

Anthony Henday, for the Hudson Bay Company, trying to encourage Western Indians to turn away from French traders, reached and followed the North, South and Red Deer Forks of the Saskatchewan River to their headwaters. He was the first Englishman to set eyes on the Rockies. The year was 1754.

For the same Company, Alexander Mackenzie in 1789, in 102 days, traversed Lake Athabaska, Slave River, Great Slave Lake and followed the River given his name until it ran, always east of the Mountains, into the Arctic. Three years later Mackenzie moved again through Lake Athabaska into the Peace River; then to the Parsnip and Fraser Rivers. Leaving the Fraser, he travelled overland to the Pacific Coast, touching it just north of Vancouver Island in 1793. Thus, for the second time, men had crossed the Divide--at extreme ends of the new formed Nation.

On the oceanside of the western land, another circumstance, accident or fate, occurred. The lines were laid out by Captain James Cook, who himself marked out from 1776 to 1779 the continental extent by sailing north of Bering Straits, Alaska and the Aleutians.

Sailing eight years after Cook, Captain Robert Gray left Boston in the ship Columbia Rediviva. Five years later, May 12, 1792, he sailed the Columbia into the River that was to be known as the Great River of the West. Fifteen days before, Captain George Vancouver, in His Majesty's Vessels, had sighted but ignored the breakers and brown colored water of the Columbia. Five months later, Lt. Broughton, of Vancouver's command, sailed one hundred miles up the Columbia and laid claim to it for Britain.

With the Western terminus finally established, those in the East moved forward to close the arc that would establish the principal natural and economic features of the last major segment of the New World.

Beginning with 1790 increased travel up the Missouri began by various companies seeking furs and trade. Such travel by the Choteaus, D'Eglise, and by Jean Baptist Truteau for the Missouri Company ended at the Mandan Villages in the Dakotas. Sioux Indians and English or both acted to bar further travel on the Missouri.

On November 30, 1803, France again took title to Louisiana, placing into effect the conditions of the secret treaty of 1800 at San Ildefonso. Twenty days later Pierre Clement Laussat, first consul of restored French America, turned the territory over to an American Governor, December 20, 1803. Upper Louisiana raised the French flag over Government House in St. Louis, March 9, 1804; a few minutes later it was replaced by the stars and stripes. Present to sign the papers of transfer was Meriwether Lewis, Captain of the 1st Infantry, who with William Clark, was under orders signed thirteen months earlier and now stationed up-river with a party ready to ascend the Missouri and discover a water route to the Pacific.

Boats of the Lewis and Clark Expedition took to the Missouri on March 14, 1804, with the aim of discovering a water route to the Pacific, connecting with Captain Gray's River of the West, strengthening American sovereignty in the West, preparing for territorial expansion and defining trade areas. The best border development on the north was also a high priority along with seeking knowledge of plants, animals, Indians, weather, seasons and natural wealth of the West.

During May, the party moved through the Lower Missouri. By June they passed the mouth of the Kaw, rising 450 miles to the west and followed the great bend of the river to the north. The summer saw the boats pass the

Platte, the Little and Big Sioux, the James draining the eastern Dakotas and the Niobrara bringing water out of the vast sandhills of western Nebraska. The winter was spent with the Mandans and the spring of 1805 saw them turn into the West. They saw the Little Missouri come in from the south through the North Dakota Badlands; the Yellowstone clear and draining the continental divide within a few miles of the headwaters of the Snake River from the south and west; and the White Earth, Poplar and Milk Rivers from the north giving promise of a route leading behind the British western posts on the way to the Saskatchewan River.

The Marias, looking in flood stage like the main stream, forced Lewis to ascend it until he was certain that it led north and not west. Yet it, too, would have led him to the Columbia through the Flathead and Clark Fork Rivers, to Lake Pend Oreille and thence to the Pend Oreille River to the Columbia.

Following the South Fork, the main stem, they reached the Gates of the Mountain above Helena and in July reached Three Forks. Naming the Gallatin, the Madison and the Jefferson, the party followed the latter and on August 12, 1805, crossed into the Columbia River Basin, touching on the way the Salmon, Bitterroot, Clearwater and meeting first the Snake near Lewiston and the Columbia at the mouth of the Snake. Thus, the third crossing of the Continental Divide was forced, this time by Americans. The route down the Columbia led past the Walla Walla, John Day, Deschutes, and Willamette Rivers in what was to be Oregon and the Lewis and Cowlitz below the Willamette.

November, 1805, saw the conclusion of a trip through the country which had been hidden, had been a mystery, and had been the goal of four nations for several centuries. The finding was that there was no Northwest Passage.

The final British ventures, like Mackenzie's and Vancouver's, while completing the geography of Northwest rivers, failed to reach into the region which was claimed by the United States as a result of Gray's finding and Lewis and Clark's explorations. In 1805, Simon Fraser travelled up the Peace River, crossed the mountains and moved part way down the Fraser and established a trading post west of the Divide before Lewis and Clark were wintering at Fort Clatsop. In 1808, Fraser continued to the mouth of the river that bears his name and came out at Vancouver although he had hoped it would lead to the Columbia.

Jefferson, writing to his Ministers in London, noted that the boundary was to be at the 49th parallel, except that if any portion of the Missouri was found to extend north of 49°, the boundary should move north in order to keep the Missouri totally within the United States.

This brief review of the Nation's expansion across the continent, the part played by its waterways--its rivers and lakes--serves as an introduction to the tremendous resource to which this study is addressed. Used primarily for the physical convenience they offered in opening new and unexplored paths, these natural water resources would prove to be important to the rapid development of the new Nation. Providing locations for colonies, forts and small mills, avenues of transportation and commerce, they later became economic necessities to new and growing industries for water, power and to serve in connection with the new invention of steam engines. Agriculture, crowded initially into valleys, shared location in the bottoms with industry and were subject to periodic devastating floods. The towns grew into cities and millions depended on the rivers for urban water supplies. Finally agriculture would demand immense quantities to feed these same millions.

CHAPTER II

THE COLONIES

Viewed from La Salle's grand strategy, the Colonies were well on their way to being surrounded by the time England assumed control of New Amsterdam in 1665. French penetration from the St. Lawrence Valley into the Mississippi heartland guarded the North and West. Spaniards to the south forced the founders of Charleston to move north from Port Royal Sound to the junction of the Ashley and Cooper Rivers.

Spanish and French galloped in long strides across the continental interior searching for gold, furs, riches, and Indian converts. The Colonists, unhurried, were building homes, towns and an agricultural society. They were developing laws and crowding the coastal shelf and moving gradually up the valleys toward the visible mountains.

The Appalachian range was not a formidable barrier. Its northern arm, leaning into the St. Lawrence, was a wilderness. Southward, the Hudson and Mohawk Rivers provided a water level route through them, but not through the Iroquois Nation. The southern extreme rounded nicely into the Piedmont and coastal plain. Here, however, were people taught war by the Spaniards and settlers received poor receptions.

But between the two ends, the broad agricultural, wooded and watered lands led back into the mountains through the most beautiful and abundant rivers on the continent. The Delaware, Susquehanna, Potomac, James, Roanoke, Santee and Savannah all led to acceptable passes. The Ohio was reachable through the Susquehanna, through the Juniata, or from the Potomac through the Kanawha. Once through the mountains, endless numbers of rivers routed through the eastern Mississippi valley. The Miami, Muskingum, Wabash, Illinois, Kanawha, Kentucky, Tennessee and Cumberland. And on these would be located endless numbers of Americans and the greatest complex of works yet devised by man.

Water in pre-revolutionary America was, as it always has been, a necessary and useful commodity. Rivers by now accustomed to serving transport also facilitated early industry. Hardly a community did not have a sawmill or grist mill supported by water power. The rice crops of the South benefitted by the introduction of irrigation as early as 1724. (5) Charleston rice exports mounted from 45,000 barrels in 1734 to 90,000 in 1755. Manufacturing industry, limited by English mercantilism, provided primarily those items of short supply or those not available in England. Lumbering, naval stores, and crude iron represented important industrial commodities. Together with fish and agricultural products, they furnished the exchange value for finished merchandise imported from England. The water demands to produce the quantity and variety of goods was negligible in a country where every town had available to it an abundant supply.

Water's greatest impact on the human senses came about as a result of the need for drinking supplies and for recreation.

It is not strange that modern Americans feel the right to demand protection of those natural resources which provide the basis for hunting and fishing. As early as 1641, the Massachusetts Bay Colony decreed that "Great Ponds" ten acres of fresh water and over should forever remain open for "fishing and fowling". (6)

While the Massachusetts Colony passed regulations for the prevention of pollution of Boston Harbor in 1647, (7) for public health protection, a South Carolina statute in 1726 prohibited pollution harmful to fish. (8)

In 1709-10, the Massachusetts Colony forbid the creation of any

"Disturbance or incumbrance...on or across any river..." that would operate to stop or obstruct the natural passage of fish, "...without the approbation and allowance first had and obtained from the general sessions of the peace." (6, p. 52)

The deep roots of this tradition, transposed from the English world and carried to a new setting, is nowhere better illustrated than in Izaak Walton's contribution. (9) On Monday, May 9, to May 16, 1653, an advertisement in The Perfect Diurnall, England, read:

> The Compleat Angler, or the Contemplative Man's Recreation, being a Discourse of Fish and Fishing, not unworthy the perusal of most Anglers, of 18 pence price. Written by Izaak Walton. (9, p. 7)

Although scientific investigation was gaining a foothold in astronomy, natural history, physics, mathematics, and in botanical collections, knowledge available in England in practical agriculture and animal husbandry was not applied in Colonial America. One observer remarked that in all that concerned cattle New England farmers were, "...the most negligent ignorant set of men in the world. Nor do I know any country in which animals were worse treated." (10, Ch. IV)

Human husbandry was similarly affected, although with more justification. During the Colonial period, medical, scientific and public health knowledge capable of protecting the individual from the hazards of contaminated water was not known. Public health organization was practically non-existent. Disease was believed propagated and spread by decomposing animal and vegetable matter and other unfavorable influences. Thus, sanitary practices were limited to attempts to encourage cleanliness and discourage the disposition of gross matters to watercourses used by human habitation. In the absence of sewers carrying fecal matter and the relatively small size and number of towns, waterways in their neighborhood probably were nominally polluted, except after rains washing farm, field and town.

In the main, dug wells, surface water and cisterns for rain catchment provided for drinking water supplies. The first authentic record of a public water supply (11) was "The Water Works Company of Boston". This system established in 1652 provided domestic water and fire protection service only to the residents of Boston's Conduit Street.

Not until almost a century later did the first supply designed to serve an entire community come into being. Then it was that a farmer named Schaeffer piped a supply from a spring on his farm down the main street of the Pennsylvania village now named Schaefferstown in his honor. The exact date of the project is obscure, but it is recorded that the system was operating in 1750 and that it was taken over by the municipality in 1763.

Meanwhile, at Bethlehem, Pennsylvania, in 1754, immigrant millwright Hans Christiansen, with the assistance of a visiting West Indian missionary, John Boehner, began work on the first pumped public water supply works, placing the works in regular operation in 1755 and completing the project in 1761. And some years later, in 1774, Moravian brethren who had headed south from Bethlehem to found Salem (now Winston-Salem), North Carolina, began work on a gravity water system and piped in their first supply in March, 1776.

Practically all of the early supply works consisted of a short pipeline bringing water from a nearby spring or stream by gravity; generally there was no storage other than that provided by the intake or diversion works. The bored wood or lead pipe employed was of such limited capacity as to supply only the most meager domestic needs of the consumers, provision for fire protection being almost entirely absent. It was the later introduction of cast-iron pipe, first imported from England, which made possible larger-diameter lines capable of carrying the tremendous volumes of water actually required.

CHAPTER III

1776-1865

At the same time the Continental Congress was issuing its Declaration of Independence against the mother country, Jeremy Bentham in the same mother country was laying the philosophic basis for the reforms that would be necessary during the 19th century to bring into reality the promises held out by Independence.

Bentham's Fragment of Government (12, Ch. XXXI) outlined, in 1776, his concept of utilitarian thought. Essentially, it was a criticism of Blackstone's Commentaries, an attack on the legal profession and Whig concept of government. At best, Blackstone was merely expository, describing law as it is; at worst, it stood as an apology for the status quo. Bentham held that the true function of jurisprudence is "censorial", the criticism of the legal system with a view to its improvement.

Such criticism required a standard of value. Bentham suggested his utilitarian view, "It is the greatest happiness of the greatest number that is the measure of right and wrong." This view Bentham ascribed to David Hume, who had stated -- The basis of government is not contract but human needs, and the satisfaction of human needs is its sole justification.

Terms like rights, property, the crown, the general welfare are all liable to fictional use, and usually were used, Bentham noted, for defending vested interests. Corporate bodies, as society - a state, were fictitious. Whatever is done in its name is done by someone, and its good, Bentham said, "...is the sum of the interests of the several members who compass it."

The value of Bentham's principle was its use as a solvent for fictions. It meant that the real significance of a law or an institution must be judged *in terms of what it does, and so far as possible by what it does to specific individuals*.

Sabine suggests that Bentham gave more thought to ad hoc considerations than he realized; that the formal development of his views were in full recognition that legal reform in his day was largely a matter of getting rid of obsolete practices. In the century following Bentham, English jurisprudence was modernized and reformed. It has been stated that every important reform of English law during the 19th century is traceable to the influence of Bentham's ideas, and that few social philosophers exercised as wide and beneficent an influence.

By 1776, the industrial revolution was well underway in England. Science was moving rapidly and inventions existing or being developed were creating the ever-widening material road along which the 19th century would travel. The social philosophy expressed by Bentham was greatly needed at this juncture in human affairs if the values resulting from the scientific gains were to be made available to the people. The twin births of "the Rights of the People to alter or abolish..." governments, and the expression of the role of government as the satisfaction of human needs based on the criteria of the greatest happiness of the greatest number was, to say the least, fortuitous. At best, it made it possible for the new Nation to be unbound from the past and, like England, move to governmental reforms that gave greater respect to the individual person. It was to be reflected in social and public health reforms and in the continued establishment and improvement of laws for the benefit of the "general welfare." It continues in its sharpest aspect today in conservation policy, expressed by the U. S. Forest Service, as the "Greatest Good to the Greatest Number."

Analyzing the progress made by science, Conant (13) has identified about a thirty-year time lag between the initial statement of a new scientific thought and the broad acceptance of the idea in the practicing scientific world. In the 18th and well into the 19th centuries, ideas recreating and redesigning the political, social, economic and physical world came thick and fast. During this effervescent period, however, few new ideas occurred in man's water environment affecting it qualitatively. The new Nation, beginning to get its house in order while convulsing within itself to divide, marshalled its energy and showed quantitatively its ability to use its vast resources for the common good.

Water Supply

Urban water supply was not a matter of major concern, to the Nation, merely because a very small portion of the population lived in towns. For the town dwellers, problems of unpaved streets, drainage, dirt and filth, inadequate police protection and fires were main concerns. Water, not yet related by science to disease transmission, was sought for in new and improved ways as a matter of convenience and necessity.

In 1799 a small section of Philadelphia was served water through wooden pipes. The source was the Schuylkill River; the power obtained by the new steam pumps. By 1822, iron pipes carried water to the entire city from the Fairmount Waterworks. The first central water supply for New York was an effort of the Manhattan Water Company, created by a legislative act sponsored by Aaron Burr, in reality a banking company to compete with Alexander Hamilton's New York Bank, This company led the way to the water supply developed at Groton Reservoir in 1842. (10, p. 208)

Beginning with less than sixteen waterworks in 1800, by 1860 over 400 major water systems served the Nation's major urban centers.

Navigation

In another, quantitative, aspect of water, the Nation moved rapidly to serve its growing needs. With independence in 1776, the basis of trade shifted from mercantilism to economic necessity, but continuously with England. Until the mid-1800's, this trade amounted to over 50 percent of the new United States' trade. The urgency of trade provided a sound base for the ship building industry. By 1815, the American flag was raised over a thousand vessels and was being carried to every part of the world.

Cotton, moving from a relatively unimportant crop in 1794, compared to tobacco, accounted for 40 percent of the Nation's total exports by 1837. Contrasted with this export of the South, largely through southern ports of Savannah, Charleston and New Orleans, wheat, flour, beef and pork began to move as export commodities from the new western territories of Ohio, Illinois, Indiana, Michigan and Kentucky.

Western settlement and economic development depended on communications. The national road from Cumberland to Wheeling provided the earliest link to the West. But freight charges overland proved prohibitive and the natural network of waterways along the eastern coast, the Ohio Valley and the Great Lakes became the major economic network linking the former colonies and the new Western States. The great waterway era was opened wide in 1807 with the technological advance created by Robert Fulton when he hitched his paddle wheel boat to a Boulton and Watt low pressure steam engine imported from England.

While water and steamboat together made possible the physical realities of inland navigation, effective navigation was hindered by the hazards inherent in uncontrolled rivers, shifting channels, snags, floods, low water and the fact that direction of flow was not attuned to the needs of commerce.

Early artificial controls to strengthen river navigation had been undertaken on the Potomac and James Rivers before 1789. George Washington had been a strong advocate of such works designed largely to bypass rapids and bring the resources and products of the upper watershed to tidewater.

Between 1789 and 1837, twenty-five hundred miles of canals were built. (14) In the eighteen years 1820-1838, eighteen states authorized credit advances of $60 million for canal construction. More important than these impressive statistics for the young Nation were the governmental designs that were undergoing formation, the principles of which are applicable to the Nation in the Twentieth century. Indeed, the same issues, debated in every period, appear now to be themselves part of the national design, important to our continued reappraisal of locus of power between the States and the Federal government.

Gallatin and Internal Improvements

Leaving Hamilton to lay out his broad design for manufacture in the new Nation, Albert Gallatin, Jefferson's Secretary of the Treasury, shaped the role of the Federal government in the matter of internal improvements. (15) The aim of such improvements--roads, canals, river improvements and the like--would be to "contribute toward cementing the bonds of the Union between those parts of the United States whose local interests have been considered as most dissimilar." This Federal action, at Federal expense, was to come as soon as the public debt was liquidated. Jefferson, too, held this view, and his second inaugural address declared that, upon redeeming the public debt, "the revenue thereby liberated may...be supplied, in time of peace, to rivers, canals, roads, arts, manufacturers, education, and other great objects within each state."

Gallatin was willing to read into the Constitution the right to use Federal monies for internal improvements. Jefferson taking a more conservative view, believed a Constitutional amendment necessary to inaugurate such a national program. While not affecting water interests, the local pressures developed in connection with the Cumberland, the National, road foretold the stresses that would have to be considered in Federal supported projects.

The details of Gallatin's master plan of internal improvements were laid before Congress in 1808, after a year of effort assembling ideas from all parts of the Nation. His report, asking $50,000 for preliminary survey, had a total price of $20 million. At $2 million each year, the projects outlined could be achieved in ten years. A permanent revolving fund in the Treasury, financed by bond sales to individuals would provide for a continuing program of improvements.

The network of canals and river improvement would bring the North and South together; canals were to be built from Boston to Buzzards Bay, from the Raritan River across New Jersey to the Delaware River, across Delaware to Chesapeake Bay and through the Dismal Swamp of Virginia (that Washington had at one time hoped to drain) and North Carolina. Even then Gallatin saw the future inland waterway along the East coast stretching from Boston to Georgia. The West was to reach back to New York and New England by canals from the Hudson River to Lake Champlain and Lake Ontario, and a canal was to bypass Niagara Falls.

The yardstick to measure the value of Federal grants was not to be the population of the States in which the improvements were to be located. "Roads and canals are often of greater utility to the States which they unite than to those through which they pass."

Debating this yardstick with President Jefferson, who desired apportionment based on State population and a Constitutional authorization, Gallatin foresaw embarrassment as a result of strict Constitutional rule and supported the view that, "A just apportionment will naturally result from the conflicting interests on the floor of Congress."

Adoption of his plan, he hoped, would avoid waste and corruption characteristic of piecemeal and haphazard developments. While Congress failed to adopt it then, its basic principles are valid today, and while total piecemeal construction has been avoided, greater efficiency in this matter is needed and desirable.

John Quincy Adams, following non-enthusiastic Presidents Madison and Monroe, sought, like Gallatin, a bold and orderly system of improvements. Using the Army Corps of Engineers, authorized by Congress in 1824 to look after internal improvements involving navigation, over $2 million was spent during his term, exceeding all his predecessors. These works include surveys, light house building and dredging of rivers and harbors. Even with Henry Clay's aid, nothing of great significance was accomplished and Jackson, reverting to strict Constitutional reading, refused further Federal authorizations and cancelled various canal grants in being.

Yet, twenty-five hundred miles of canals had been built, largely in private subscription, speculation and with State support. Lack of Federal aid did not hinder the speed of development; it could have helped both in orderliness and in fiscal soundness. While even today an issue is whether, and the degree to which, the States shall participate financially in resource projects, it is interesting to note the extensive direction, both policy and fiscal, that States exercised over internal improvements by the 1830's.

Whether the speculative nature of many of the improvements led to the severe depression of 1837, or whether Jackson's feud with the Bank of the United States, the citadel of money power and a private institution, and the problem of currency stablization provided the underlying reason; whatever the reason, the States withdrew markedly from involvement in large internal improvements and halted what might have been a normal development of government-owned transportation. This characteristic, safeguarded carefully in revised Constitutional provisions over the years, has been an important factor in restricting State activities in financing water resource projects. (10)

While canals and railroads together played an important part in providing transportation facilities, the river system continued, until after the Civil War, to play the major role, but gradually yielding way to the newer forms of roads and steam railroads.

Although the science and technology of the industrial revolution continued to advance through the first half of the 19th century together with the opening of the western frontier all the way to the Pacific, no basic changes occurred in the water environment. Navigation improvements, piped water supply for urban centers and expressions of State policy regarding protection of waters for fish and wildlife from visual pollution comprised the major advances.

Early expression of the new scientific world forming was to be found in the establishment of Geological Surveys by the States to compile and catalog all facets of State resources. (6, pp. 35-39) The first official survey was initiated by North Carolina in 1823. Between 1829-1841, Massachusetts conducted the most comprehensive survey, including the preparation of a map showing, "...the names, courses and magnitudes of rivers and streams", and "...ferries, falls, ponds, shores, harbors...." In the 1830's, sixteen States established such agencies; by 1860, thirty had been established.

Probably the most important actions affecting the water environment during the period occurred, not in the physical or scientific development, but rather in the political philosophy expressed largely through the court headed by Supreme Court Justice John Marshall.

The Supreme Court

Although the Founding Fathers had drawn a tri-partite creation of government with checks and balances, the actual form resulting from day-to-day operations was not altogether in keeping with their views. By 1830, the outlines of national and State governments and politics had hardened, and the

Supreme Court was the anvil on which many decisions were hammered out.

Beginning as early as 1796, the Court began the process of expounding the Federalist view of government by (1) holding Federal treaty rights superior to State law (Ware vs. Hytton) and (2) determining the constitutionality of Congressional Acts by upholding a Federal tax (Hylton vs U. S.).

John Marshall, appointed to the Court by John Adams as a final act preceeding the entrance of President Jefferson, carried on for thirty-five years his consistent Federalist doctrines of centralization of Federal powers over the States. "Let the end be legitimate," he said in McCulloch vs. Maryland (1819), "let it be within the scope of the Constitution, and all means which are appropriate, which are plainly adapted to that end, which are not prohibited but consistent with the letter and spirit of the Constitution, are constitutional."

In Gibbons vs. Ogden (1824) he used this reasoning to create the basis for the Federal government's important role in water resource development. The situation was created by the State of New York granting exclusive rights to Robert Livingston and Robert Fulton to navigate the waters of New York State by steamboat, an award for the inventor of "Fulton's Folly." Subsequently, this right passed to Ogden who, in turn, sued to restrain Gibbons from operating steamboats on the Hudson River. Because of its important historical and continuing significance, it is worth examining. (103, p. 238)

Gibbons, in appealing to the Supreme Court, cited the Constitution. He appealed against the granting of executive privilege on the basis of two clauses in the Constitution; that which authorizes the Congress to regulate commerce and that which authorizes Congress to promote the progress of science of useful arts. Justice Marshall responding to a request to construe strictly these Congressional clauses replied that, "...if...narrow construction...would deny to the government those powers which the words of the grant, as usually understood, import, and which are consistent with the general views and objects of the instrument; for that narrow construction, which would cripple the government, and render it unequal to the objects for which it is declared to be instituted, and to which the powers given, as fairly understood, render it competent; then we cannot perceive the propriety of this strict construction, nor adopt it as the rule by which the constitution is to be expounded."

With respect to the words "congress shall have power to regulate commerce with foreign nations, and among the several States, and with the Indian Tribes," the Chief Justice noted that the subject to be regulated is commerce, and that to ascertain the extent of the power it becomes necessary to settle the meaning of the word. Commerce, he held, is not only traffic but includes intercourse between Nations. The power of commerce, including navigation, was one of the primary objects for which the people of America adopted their government, and must have been contemplated in forming it. Commerce, as used in the Constitution, has been universally admitted to comprehend every species of commercial intercourse between the United States and foreign nations and among the several States. He argues further that commerce cannot stop at the external boundary line of each State, but may be introduced into the interior; that while completely internal commerce of a State may be considered as reserved for the State itself, with respect to foreign nations, the power of Congress does not stop at jurisdictional lines of the several States. The deep streams which penetrate our country in every direction pass through the interior of almost every State in the Union, and furnish the means of exercising the right. If Congress has the power to regulate it, that power must be exercised whenever the subject exists. If it exists within the States, if a foreign voyage may commence or terminate at a port within a State, then the power of Congress may be exercised within a State....

Finally, the Chief Justice notes that powerful and ingenious minds, taking as postulates that the powers expressly granted to the government of the Union are to be contracted, by construction, into the narrowest possible compass, and that the original powers of the States are to be retained, if any possible construction will retain them, may, by a course of well-digested, but refined and metaphysical reasoning, founded on these premises, explain away, the Constitution of our country, and leave it a magnificent structure indeed, to look at, but totally unfit for use. They may so entangle and perplex the understanding as to obscure principles which were before thought quite plain, and induce doubts where, if the mind were to pursue its own course none would be perceived. In such a case, it is peculiarly necessary to recur to safe and fundamental principles, to sustain those principles, and, when sustained, to make them the tests of the arguments to be examined.

Early Federal Aid

A number of other actions, primarily legislative, were undertaken during this period while bearing on water, the actions were largely of concern in connection with associated land issues. Thus the Pre-emption Act of 1841 provided, in Sections 8 and 9, for granting to each State of 500,000 acres of land and provided that the proceeds from the sales of such lands, "...shall be faithfully applied to objects of internal improvement...namely, roads, railways, bridges, canals and improvement of water-courses, and draining of swamps...." (16, Ch. 2)

After nearly twenty-five years, Congress, in 1849, acted to grant to Louisiana, "the whole of those swamps or over-flowed lands, which may be, or are found unfit for cultivation." Proceeds of the sales of such lands were to be used for levee and drainage construction. Similar grants were made to twelve additional States in 1850 and to two others (Minnesota and Oregon) in 1860. Involving some 65 million acres, only a small portion of the proceeds were used for the purposes intended, and the General Lands Office Commissioner, in 1887, noted that the purpose of the Acts (to reclaim land) were largely defeated.

Internal Improvements

From the viewpoint of water resource development, the most important issue revolved about the means of accomplishing internal improvements. This issue, raised early in the national debates, cast a long shadow ahead, well into the twentieth century.

Following Gallatin's proposal, in 1808, for a ten-year national program of internal improvements, to be financed from excess revenues and a revolving fund, William Lowndes of South Carolina, in 1818, submitted four resolutions to the House of Representatives on internal improvements. While the House initially approved 89 to 75, their right to appropriate money for building military roads and other land routes, canals, and improved natural waterways, subsequent debate on the constitutionality question resulted in a rejection of these proposals. The general principle of non-Federal involvement was continued up to 1822 with President Monroe's veto of the Cumberland Road Bill, which was sustained in both Houses of Congress.

By 1824, western interest spearheaded widespread demand for more and improved internal routes. The result was the General Survey Bill empowering the President to initiate surveys and estimates of roads and canals required for national military, commercial, or postal purposes. On February 10, 1824, the House passed the Bill, 115 to 86. The beginnings of the traditional line-up by sections for internal improvements can be seen in this vote. (15)

	For	Against
New England	12	26
The West	43	0
The South	23	34
The Middle States	37	26

The Senate passed the Bill, 24 to 18.

Despite his own view of Federally financed internal improvements, President Monroe nevertheless saw his term of office draw to a close with important decisions made on this matter both in the Executive Branch and the Judicial Branch as a result of Justice Marshall's opinion in Gibbons vs. Odgen.

The election of President John Quincy Adams in 1824 placed an Executive sympathetic to Federally supported projects in charge of carrying out the provisions of the General Survey Act. In addition, President Adams sought to stimulate science, supported the establishment of a scientific expedition to seek knowledge of the West Coast and the River of the West (Columbia) and worked for an uniform and improved system of weights and measures.

Expenditures for the years 1822-4 for river and harbor improvements were $530.00, $99.00, and $25,842.00 respectively. Expenditures during Adams' term, 1825-28, increased from $40 thousand to $188 thousand. (24)

While President Jackson referred, in his first annual Congressional message (December 8, 1829) to the constitutional objections that had been raised against internal improvements, his record reflects the actions of a seasoned political leader rather than an avid opponent of such improvements. Recommending apportionment of surplus revenues to the States according to Congressional strength for expenditures by them, he also was heeding Martin Van Buren's advice to put an end to Congressional logrolling which was creating increased construction of internal improvements of Federal expense.

Van Buren's object was political, using this restriction to strike at Henry Clay's party and who, personally had vigorously supported such improvements under John Quincy Adams. In his Maysville Road Veto (1830) he declared, on the ground of expediency and strict constitutional construction, his view that (a) the proposed road had no national implication, and (b) that, if Federally subsidized roads were thought desirable, a Constitutional Amendment should sanction them. This concession to States' rights did not interfere with his general support of internal improvements; thus keeping the support of the West and North. While subsequently he terminated contracts on roads and canals, during his administration's eight years, more than $5 million were expended on river and harbor improvements and over $7 million on roads and canals. (24)

The Democratic convention of 1835 nominated Van Buren for President, with no platform except that outlined by Van Buren in a letter in which he proposed to follow the lead of Jackson. Following four years of Democratic administration, the Whigs, in 1840, nominated and elected William Henry Harrison President. The Whigs stated no platform in this campaign while the Democrats, keeping to strict construction of the Constitution, opposed Congressional interference with slavery, opposed a national bank and internal improvements at national expense.

Yet, between 1837 and 1844, expenditures continued, although at a lessened rate, for internal improvements. Thus, nearly $4 million were spent for rivers and harbors and $2.7 million for roads and canals. Much of the reduction for roads and canals was a result of the financial collapse of 1837 and the beginning of the technological shift of transportation to railroads. (24)

Finally, with the period drawing to a close, Carl Sandburg notes that Congressman Abraham Lincoln included in one of his periodic addresses on the floor of the House, moderate support for river and harbor and navigation improvements then being considered. In 1860, the Republican party platform reiterated its belief in the Declaration of Independence and resolved, "that appropriations by Congress for River and Harbor improvements of a National character, required for the accommodation and security of an existing commerce, are authorized by the Constitution, and justified by the obligations of Government to protect the lives and property of its citizens."

Comparison of political policies of either party, with dollar expenditures for internal improvements, leads to the conclusion that the basic needs demanded by the Nation in its development were the over-riding considerations to which Congress and the Government responded. In succeeding periods, this conclusion appears many times.

CHAPTER IV

1865-1900

The thirty-five years leading to the end of the century saw the Nation reap the full benefits and the detriments of the industrial revolution. With its political organization problems largely left behind; with the boundaries settled, the land filling up and the frontier dwindling; with the "house" no longer divided or threatened, the tremendous impetus given industrialization by the Civil War began to make an impression on the Nation. Associated with industrialization were the new forces released by scientific discoveries. Together, they created and made possible the urbanization that rapidly took form. Urbanization, crowding the flood plains of the Nation's rivers, together with more intense cropping of marginal and flood plain land, raised the annual anticipated rise of rivers to new dimensions. The result was an ever-mounting disaster problem, to be attacked through a program of flood control, justified by a tie to the development of navigation and river and harbor improvements. The last large factors affecting this period were the development of extensive transportation facilities and a renewed interest in the West, resulting from a critical and realistic appraisal of its resources.

This section discusses water resource developments in terms of: (1) scientific developments during the period; (2) industrialization and problems associated with industrial water use; (3) power; (4) urbanization and the important concomitant factors of public health and water supply considering the new science of bacteriology; (5) the Federal internal improvements, including the impact of railroad development and the associated problems of navigation and flood control; and (6) the second opening of the West, involving the intimate relations of western lands, water supplies in the arid country, and the associated developments in irrigation and water law.

Scientific Developments

The period was marked by a further increase in the rate of scientific findings in a wide variety of work. Further foundations were laid for the subsequent intensive development of the chemical industry, with M. C. Lea's work on platinum minerals, photochemistry and photosalts; with developments in analytical techniques by Cooke (volumetric analysis) and O. W. Gibbs (electrolytic analysis) and the work of Ira Remsen, the founder of university graduate work in chemistry (Johns Hopkins), as well as the finder of saccharin.

The geological maps of the United States, including the glacial formations, were completed, and major contributions were made to stratigraphy, so essential to the further work and understanding of ground water. James J. Sylvester at Johns Hopkins founded the American Journal of Mathematics, and, at Yale, Josiah Willard Gibbs published his "Elements of Vector Analysis", thereby setting the stage for further refinements in mathematics employed in structural design.

Of great importance during this period was the full development, scientifically supported, of the concept of quality of water. While Leuenhoch had first seen his "little animals" in his crude hand-ground lens nearly two hundred years previously, the science of observing and developing knowledge of microscopic life proceeded slowly. The major development phases passed with long intervals (17, pp. 6-10); in 1780 the Danish biologist Otto Freidrich Muller published his "Animalcula Infuseria Fluriatilia et Marina"; Ehrenberg contributed his classical systematic study of microscopic organisms by 1838; the practical significance of study of organisms resulted from studies of Dr. Hassall in England (1850) in connection with microscopic analyses of drinking water and the interpretation of analyses. By 1853 Ferdinand Cohn in Europe developed his treatise on living organisms in drinking water and indicated the correlation between aquatic life and water purity.

In the field of limnology, Peter Erasmus Muller in 1867 observed in Swiss Lakes the presence of lower crustacea. Up to this time, water in clear lakes was believed to be free of microscopic life. This study laid the basis for limnological research. Muller was followed by Professor F. A. Forel in Switzerland. His studies on Lake Geneva, "Le Leman", was epoch making and helped establish the Limnological Commission in Switzerland.

In 1893, Professor R. E. Reighard, working for the Michigan Fish Commission, began biological studies on Lake St. Clair, followed by Professor Henry Ward and his studies on Lake Michigan.

The study of the effect on water of sewage and trade wastes was carried out by Gerardin in his observations of the noxious conditions of the River Fault.

The major contributions to this development, of course, were those of Louis Pasteur and Robert Koch in the 1860's and '70's. Here was the conclusive proof of the relation of living organisms to health--the proof of the germ theory of disease.

Thus, as a result of this long series of developments, a start was made on the systematic examination of water supplies in the United States for quality control. The Massachusetts State Board of Health is credited with making the first effort along this line, in 1887, of all water supplies in the State. A less intensive survey was initiated two years later by the State Board of Connecticut. In 1889 the Water Board of Boston, at its Chestnut Hills reservoir, established a laboratory for the systematic study of the biological character of water supply sources. By 1897 general water analysis and microscopic examinations were being made by the Mt. Prospect Laboratory of the Brooklyn, later the Greater New York City Water Supply.

Hydraulic research, Rouse points out, (18) was largely a product of European investigators, Nevertheless, interest in open channel research was greatly stimulated by the expansive report of Captain A. A. Humphries and Lt. H. L. Abbot of the Bureau of Topographical Engineers in 1861. Their "Report on the Physics and Hydraulics of the Mississippi River" resulted from investigations following unprecedented Mississippi River floods. The report found favor largely through its extensive review of all known European literature on channel resistance as well as for the authors' attempt to formulate and apply their own theoretical views for river control.

Late 19th century advances in the United States were shared by three men: Lester Allen Pelton--who, in 1878 and 1879, developed models of water wheels which he tested at the University of California and subsequently patented (1880); Clemens Herschel--a civil engineer who devised the venturi water meter; and John R. Freeman--who did original investigations and studies and wrote on hydraulics of fire streams.

Industrial Development

Industrial America gained greatly as a result of the Civil War. The agricultural forces responsive to large southern landowners decreased; legislatures responded to industrial requirements; the Morrill Tariff Act (1861) provided high protection to domestic industries and the wartime demands for woolens, munitions, and food strengthened immeasurably the factory system.

Western expansion, population increase and rehabilitation of the South produced an expanding demand for manufactured goods after the War. New inventions produced new industries and advertising and foreign markets helped expand the demand. Economic growth during the period 1859-1899 is indicated in the following table.

TABLE 1

ECONOMIC GROWTH, 1859-1899 (10)

Year	Population	Value Agricultural Products in $	Value Manufactured Products in $
1859	31,433,000		1,886,000,000
1879	50,155,000	2,313,000,000	5,370,000,000
1899	75,994,000	4,717,000,000	11,407,000,000

During this forty year period, major advances occurred in industries dependent on the availability of large volumes of water. These included meat packing, canning, textiles, woolens, rayon, iron and steel, chemicals, petroleum and wood pulp and paper and paperboard production. By 1900 industrial requirements were probably in excess of 10 billion gallons of water per day.

Pork packed in brine barrels accounted for the larger portion of the total of 27 percent of all meat products of Cincinnati in 1850. Fifteen years later, Chicago was the Nation's meat handler, served by nine railroads, 200 acres of stockyard and prepared to load 500 cars daily. Other food processing was stimulated by the development in 1861 of adding calcium chloride to the cooking bath which shortened the preparation time from 5-6 hours to 25-30 minutes. Machine made, open-topped tin cans, lacquer lined and automatically sealed, replaced hand closed cans in 1885 and completed the early basic structure of the food processing industry.

The textile industry, well established in New England, made major adjustments toward automatic machinery during the period. While the number of plants remained about one thousand, production quintupled between 1850-1900. By 1900 nearly forty percent of production had shifted to the southern cotton growing states.

Man-made fiber, rayon, was introduced about 1890. Demanding vast amounts of water (100 gallons per pound acetate yard) and chemicals, it was the forerunner of the extensive synthetic industry of the mid-twentieth century.

The Bessemer process (1866) shifted a three-month process to produce steel to one-half hour. Between 1860 and 1880, the number of works increased from 402 to 1,000; capitalization from $23.3 millions to $230.9 millions; value of product from $36.5 millions to $296.5 millions and employment of 22,000 to 141,000. The growth of United States steel production in comparison to other leading world producers for the period 1870-1900 is shown in Table 2.

TABLE 2

STEEL OUTPUT IN THE WORLD AND MAJOR PRODUCING COUNTRIES 1870-1900 (19)
(Million metric tons)

Year	World	United States	United Kingdom	France	Belgium	Germany	Russia-USSR
1870	0.7	0.1	0.2	0.1	0.1	0.2	0.1
1880	4.4	1.3	1.3	0.4	0.1	0.7	0.3
1890	12.4	4.3	3.6	0.7	0.2	2.2	0.4
1900	28.3	10.4	5.0	1.6	0.7	6.6	2.2

Common chemicals for meat-pickling, tanning, dyeing and soap making were required by Colonial America. The Civil War demands were largely in explosives, sulphur and starch and glue. Organic chemistry began to produce, by 1880, simple structured industrial, food, medicinal and dye chemicals. Between 1880 and 1900, alkalis, (caustic, soda ash, lime) sulphuric acid and other inorganic chemicals came into higher production. By 1899, there were 7,669 establishments employing 169,862 persons. (19)

The petroleum industry laid its first pipeline in 1865 and refineries developed around Pittsburgh and Cleveland. By 1899, the industry was well established in producing a wide range of petroleum products. The average yield of principal products of crude oil between 1880-1899 is shown in the following table.

TABLE 3

PETROLEUM REFINING
OIL REFINING: AVERAGE YIELD OF PRINCIPAL PRODUCTS FOR CRUDE OIL IN THE UNITED STATES, 1880-1899 (20, pp. 2-5)
(Percent of total)

Year	Gasoline	Kerosene	Gas, Oil & Distillates	Residual Fuel Oil	Lubricating Oils	Other
1880	10.3	75.2	-	-	2.1	12.4
1889	12.8	65.9	-	-	7.7	13.6
1899	12.9	57.6	14.0	-	9.1	- 0.4

The period 1860-1900 can be viewed, then, as the time during which the fundamental industrial base of the Nation was developed, although as we have already noted, the factory system had become well developed since the turn of the eighteenth century. The index of manufacturing production increased nearly 900 percent between 1863 and 1900. Industrial development, through increasing technologic advances, moved substantially toward the major processes on which twentieth century industry was based. Distribution of industry had begun to extend beyond the Mississippi, and the industrial Northeast had already felt the transition of industry, although in a relatively small way, to the south and east-north central States. With this growth and expansion, water for industrial purposes and power grew apace. (21, 22)

Power

By the mid-19th century, American mills and factories were making general use of steam power technology. More varied public use started with the opening of Edison's Pearl Street Station in New York City, September 4, 1882. The Babcock and Wilcox boilers required daily five tons of coal and 11,500 gallons of water to serve a load of 59 customers using 13,000 lamps.

Towns like Pawtucket, Rhode Island; Patterson, New Jersey; and Lowell, Lawrence and Holyoke, Massachusetts; shared with Colonial America the innumerable wooden wheels to power grist mills. Later, after the Revolution, basic industries in such communities continued their need for water and, with growth, forced intensive exploitation of the water resources. Companies were formed to control the rivers to develop the power potential. Since power could not be transmitted, water was transmitted to customers and power was generated on the premises. Testing and experimentation on water transmission produced much data on which was built the art of practical hydraulics.

By 1882, it was still necessary to develop power close to point of use due to inadequacy of transmission facilities. Direct transformation of water power to mechanical power initially required industry to locate on rivers. Steam power eased, partly, the location problem; but the close availability of water remained highly desirable. The development of alternating current and producing dynamos opened the way for long distance transmission of power and released industry from dependence on water. Now other location factors could be given greater consideration in selecting plant sites.

The first United States hydroelectric plant developing direct current was built by Edison at Appleton, Wisconsin, September 30, 1882, but it had great limitations. The final test for use of A. C. electricity came in the developments at Niagara Falls. The energy value of the Falls had been under international discussion for many years. By 1890, construction had begun on a tunnel paralleling the river into which 238 shafts, each 150 feet in depth, were to be sunk. The proposal called for mechanical transmission of power produced by a turbine in each shaft. Prior to final development, The Cataract Company established an International Niagara Commission headed by Lord Kelvin. The recommended plan called for an A. C. system installation of three 5,000 H. P. generators. These were installed in July, 1895, and by the following year Niagara power was flowing into Buffalo.

The effect of the new A. C. power was to provide better power distribution within each plant and allowed the plant to purchase power from a control system or develop its own on the premises.

One of the first industrial units to depend solely on electrical energy was the Columbia Cotton Co. of Columbia, North Carolina. In 1894, its own hydroelectric plant powered seventeen A. C. motors of 65 H. P. each.

Higher pressures and larger units soon forced the power industry to recognize an aspect of water not usually of concern. Boiler water in the new and larger units demanded that the composition--the quality--of water be controlled. In an 1888 exposition, a new chemical trisodium phosphate was awarded a prize and the July, 1888, issue of Power Magazine noted that, "it is always well to examine, in advance, the water that is intended for boiler use." (23)

Urbanization and Public Health

Thirty-one and one-half million people, divided about 20 percent urban-80 percent rural, filled the land of the United States in 1860. By 1900, nearly 76 million, 40 percent of whom lived in cities, made up the Nation.[1]

The number of urban places grew during the forty years from 392 to 1,737. Table 4 shows the size distribution of these urban places.(24)

TABLE 4 [2]
SIZE DISTRIBUTION OF URBAN PLACES, 1860-1900

Year	Urban Places Total	Over 100,000	50,000 to 100,000	25,000 to 50,000	10,000 to 25,000	2,500 to 10,000
1860	392	9	7	19	58	299
1900	1,737	38	40	82	280	1,297

[1] U. S. Department of Commerce, Bureau of the Census, Historical Statistics, 1789-1945. Series B 13-23, p. 25.

[2] Ibid. Series B 145-159, p. 29.

While municipal water supplies grew apace with the new towns and cities (by 1900 over $1 billion had been invested in water systems) (25), health and sanitary conditions did not begin to improve significantly until the end of the period. The increase of water supply systems from 136 in 1860 to over 3,000 by 1900 contributed to major outbreaks of disease since such pumped and piped supplies, when contaminated, provided a highly efficient vehicle for the delivery of pathogens. Typical of the typhoid fever rates during the period were those of Massachusetts. Deaths per 100,000 population ranged from an average of 92 during the decade 1861-1870 to 30 for the decade 1891-1900.[1]

TABLE 5

TYPHOID AND PARATYPHOID FEVER AND RATE DURING DECADE
(Deaths per 100,000 population)

Decade	
1861-1870	92
1871-1880	63
1881-1890	46
1891-1900	30

The U. S. average was perhaps one-fourth to one-third higher than Massachusetts. Beginning in the mid-1870's slow sand filtration and later, in the mid-1880's, rapid sand filtration initiated a rapid downward trend in typhoid death rates that culminated in rates of under five per 100,000 in Massachusetts by 1916 and under ten for the Nation by 1918.

Cities of the 19th century, American and European alike, with steam pumps at hand reached into the nearest watercourse for a source of water supply. The relation of sewage dumped into these same waters to the water supply intake was not recognized through most of the period, although Dr. Snow, as early as 1854 had traced cholera to the water supply of the Broad Street pump in Golden Square. (26)

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[1] _Ibid_. Series C 56-64, p. 48.

Cholera, whose rise and fall as an international epidemic disease ran its main course during the 19th century, started its westward course from its focal point in India in 1818. By 1833, it had touched throughout Europe and crossed the Atlantic with Irish immigrants. After more than a decade of recession, it again travelled throughout the world, reaching the U. S. in 1846. In 1865, the disease appeared, this time traced in its travel and creating terror in the minds of those in its path, and found its way into the Mississippi Valley before it retreated in 1874. (27, pp. 181-2)

While cholera was marked as a disease of the slums and the poor, it hit widely. Steamers on the Mississippi were, "moving pest houses." Infection ran riot and "travelers between decks were driven incessantly to the stool by cruel purgings which marks the disease." (27, pp. 16-19) In a single week at Cairo, Illinois, docks, the ship Bride had seven deaths; the Uncle Sam, three; the Belle Key, eight; the Seraph, eight; and the Gladiator, eight.

Urbanization, widespread epidemic disease and improved knowledge stemming from the findings of the European scientists in the new science of bacteriology led to the formation of State Boards of Health. Leading the way was Massachusetts, with its State Board established in 1869, largely as an outgrowth of Lemuel Shattuck's "Census of the City of Boston" in 1845 and the "Report of the Sanitary Commission of Massachusetts" in 1850. Following Massachusetts came California (1870), the District of Columbia (1871), Virginia (1872), Minnesota and Michigan (1873), Maryland (1874), and Alabama (1875).

But Boards of Health and administrative agencies had to wait for technology to provide the tools to overcome the disaster of water-borne epidemic, and for this, dependence had to be placed on the findings of the English and Scots and their development of the slow sand filter. The first such installation was made at Poughkeepsie, New York, in 1872-74. This was followed by the development of the rapid sand filter between 1880-85. Progress in placing these new developments into practice came slowly. To Allen Hazen and his colleagues at the Lawrence, Massachusetts, Experiment Station (1892) there remained the task of developing further information on this new device. This they did in classic experiments and their findings, accepted with confidence by professionals and administrators, contributed greatly to widespread acceptance of filtration after the turn of the century.

The cause of the large water-borne epidemics was not merely the lack of water purification facilities. The concomitant condition was the discharge of human sewage into streams close enough to water intakes to provide for the effective transfer of pathogens from the waste to the water supply. Yet the science of the day was not completely unaware of the general assumption of the ability of flowing water to "purify" itself. Geddes Smith reports that, "nature will not hurry even for the Board of Aldermen, and the task that London, Hamburg and Pittsburgh laid on her (the river) was impossible." (27, pp. 181-82)

Working towards the management of waste disposal, C. F. Folsom and Rudolph Hering studied European practices at first hand between 1876-1880 and strongly influenced American practice. The Lawrence Experiment Station (1886) marked the beginning of investigation with sewage treatment in the United States and a year later (1887), Hering made the first attempt to reconcile flow and quality management by establishing a dilution ratio of 4 cfs per 1,000 people for waste disposal in the projected Chicago Sanitary and Ship canal.

The year 1887 saw the first intermittent sand filter for sewage treatment constructed at Medford, Massachusetts. In 1890, the Massachusetts Board of Health called attention to the biological nature of sewage filtration. By 1901, the first trickling filter was constructed at Madison, Wisconsin. Thus, within a few short years, the general outline of the courses of action to be followed for the next several decades in sewage treatment practice was formulated. (28)

Internal Improvements

Roads, canals and river and harbor improvements maintained a prominent position in the controversies that beset Congress and the Nation during the period. The importance of the subject was sufficiently high to demand a place in party platforms, and important national figures believed it necessary to speak their position publicly from time to time. Opponents and proponents of narrow interpretation of the Constitution continued unabated to debate the issue of the Federal role in these matters. Notwithstanding the debate, the determination of action rested, not on either side gaining a philosophical advantage, but in the degree and extent of the problem affecting the people, the importance to a wide section of the country, and to technological advance.

Roads continued to develop with Federal aid. Canals replaced by roads and railroads had seen their best days. However, navigation, for both passenger and freight travel as well as for military requirements, on inland as well as coastal waters continued undiminished, although at varying budgetary levels.

During the decade of 1851-1860, river and harbor expenditures totalled \$3.7 millions, an average of \$370,000 per year. During the five war years, 1860-65, these decreased to \$680,000, less than 20 percent of the previous decade. The postwar period saw marked advances in fuller volume of works for river and harbor improvements--with nearly \$40 millions expended during the ten years 1866-1875.[1]

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[1] _Ibid_. Series K 172-173.

Expenditures rose from $1.2 million in 1862 to a maximum of $6.4 million in 1875. During the next three years, expenditures dipped to $3.8 million.

In 1879, expenditures mounted to over $8 million, an unprecedented amount. This year, with its new budget for rivers and harbors, marked the end, in reality, of the era of debate over the role of the Federal government in this phase of internal improvements. In its place appeared an era of new and wider participation based on an acceptance of the need to meet a demanding and unceasing problem--one which had not been amenable to solution so far through State, local or private initiative.

Since Bienville's time, the lower Mississippi, taking the consolidated flood waters of the Nation from the Rockies to the Alleghenies, had subjected city and farmer to an intermittent, uncontrolled buffetting.

In 1845, Calhoun had advanced the idea that navigation and flood control were of Federal interest and had proposed a bill for general improvement of the Mississippi River, although flood control was conditional to navigation. The flood of 1849 and the failure of the subsequent Swamp Acts to resolve the problem provided a test of the idea of State action, with Federal financial aid. Between 1851-1858, locally financed levee construction reached its major development, but inadequate height, cross-section and lack of continuity brought disaster during the floods of 1852-59. (29)

During the Civil War, flood control was by-passed and actual works were lost by military operations of both the North and the South. Following the gradual build up of effort from 1865 to 1887, the Congress, on June 28, 1879, established the Mississippi River Commission to provide centralized coordination of the engineering operations needed to control Lower Valley floods. The organization was an outgrowth of the Humpheries and Abbot report of 1861.[1] (30) Their report, authoritative and a widely read document for its scientific interest, clearly indicated that flood control problems in the Lower Mississippi were beyond the ability of local interests. The nature of the report, dealing with scientific reality of flows, currents, river degradation and other physical aspects, removed the debate from one of constitutional construction over who should be responsible, to a review of who could competently finance and manage the specific tasks necessary to bring about control of this vast interstate water.

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[1] A. A. Humpheries and H. A. Abbot, Report on the Physics and Hydraulics of the Mississippi River (New York: Lippincott and Co., 1861) (30, p. 171.

While the Commission's authority included flood control as well as navigation, the appropriation acts until 1917 indicated that funds were to be used for deepening and improving the river channel for navigation. Thus, while 1882 marked the start of a coordinated system of levee construction on the Mississippi, flood control benefits were only incidental to navigation.

Internal improvements, including river and harbor developments, were directly affected by the character of the fiscal situation of the Nation following the Civil War. As a result of the War, revenues in the postwar period reached a new high, as did expenditures for nearly all functions of government. The debt of $2.5 billion in 1865 was a matter of concern to President Johnson, but of less concern to Grant. He believed normal high income and economic growth would allow the Nation to retire the debt in an orderly manner without extraordinary efforts. Federal expenses of one dollar per capita in 1789 rose to two dollars per capita in 1860. By 1869, the per capita expenditure reached $9.78. This was construed by Johnson as requiring retrenchment in public service. Nevertheless, in this atmosphere, river and harbor expenditures reached new highs as indicated.

High income, held over from wartime tax devices, coupled with debt management problems and the inability to conclude a program for early debt retirement created problems of surpluses and created a tendency to overspend, "The temptation to squander money was overshelming; the Rivers and Harbors

Act passed over (President) Arthur's veto in 1882 demonstrated how stongly it lay upon the Congress." (31, p. 71)

While surpluses continued, Executive Branch policy continued to lean heavily toward economy. Benjamin Harrison, while holding that, "Expenditures should always be made with economy and only upon public necessity..." (31, p. 75), did not hold an extreme position. On river and harbor matters, he held that it would be more prudent, "to schedule fewer projects at a time and push them to completion more rapidly." (31, p. 76)

President Cleveland urged economy and limitation of Federal expenditures his second term (1893-97) as well as carefully limiting expenses to public purposes. On the latter point, he vetoed a River and Harbors Bill because, "many of the projects were for the benefit of limited localities or in aid of individual interests." (31, p. 76)

In general, however, there was wide acceptance of the Federal stake in waterway developments; less wide but nonetheless important acceptance of the idea that the Federal government was the proper agency to deal with large scale flood problems, and a fiscal ability within the Federal government to support these activities on a higher level than before the Civil War. The significant shift in ideas of Federal interest was a part of the total awakening of the new and developing role of government; of a more clearly defined role trending away from laissez-faire toward the public sector of the economy. This role, as we shall see, was strongly carried forward after the turn of the century by Theodore Roosevelt, especially in the fields of water and conservation generally.

The Second Opening of the West

Western irrigation by United States citizens was initiated by the Utah Mormon pioneers in 1847. By 1860, 756 irrigation projects, largely diversions from stream beds to farm lands, were supplying water to 402,000 acres. These produced major supplies of food to the one-half million people living in the eleven mountain and Pacific states. By 1900, 20,000 private enterprises serving 9.5 million acres of land were under irrigation, representing an investment of $250 millions. (32)

In this fifty-year period, the West, opened to the Pacific by Lewis and Clark, saw successive waves of miners, wagon train pioneers, ranchers and farmers meet the land west of Westport Landing (later Kansas City) and its little-understood climate. The conquering of the West, while initiated during the forepart of the period, could not have been completed on a permanent basis until the second opening--the scientific opening--which took place during the latter part.

Between the Lewis and Clark Expedition and the Mormon settlement, the West was probed by numerous exploring parties. Some of the more important included the exploration of the Mississippi and its headwaters at Lake Itaska by Henry R. Schoolcraft, early Indian agent, geologist and educator, in 1831-32; the 1832-33 trapping and hunting parties into the Rocky Mountains, led by Army Captain L. E. Bonneville, and the first overland expedition from Independence, Missouri, to Oregon in 1834, under Nathaniel Wyeth. Two other important ventures leading to familiarity with the vast distances of the West were the expeditions of Reverend Jason Lee to the Willamette Valley in 1834 and Dr. Marcus Whitman to the Green River (Wyoming), Oregon, and the founding of the Walla Walla Mission in 1835-36. By 1842, Army expeditions under John C. Fremont began to contribute scientific observations.

The mineral frontier had a major effect on the political and economic development of the West. It also set the legal basis for the relations between water and western land.

By 1860 placer gold findings, responsible for starting the '49 gold rush, had been largely worked out, and discoveries had shifted to Lake Tahoe and the Pikes Peak country. In the decade 1858-68, thousands of miners moved through the western lands. Their presence and the social habits of man created a demand for division and subdivision of the territories, resulting ultimately in the establishment of new states.

The influx in the Pikes Peak country brought into being the Territory of Jefferson in 1859. By 1861, Congress renamed it the Territory of Colorado--created out of parts of the territories of Kansas, Nebraska, Utah and New Mexico--and statehood was achieved by 1876.

Simultaneously, the rich Carson Valley find in western Utah in 1859 forced the creation of the Nevada Territory out of Utah in 1861. Nevada statehood was granted in 1864. New discoveries on the Clearwater and Snake Rivers established new situations. The result was the creation of Idaho (1863) out of the Washington, Dakota and Nebraska Territories. This was followed by the new Territory of Montana (1864) out of Northern Idaho and Wyoming Territory (1868), from three existing territories. Previously, in 1863 Arizona had been created out of New Mexico Territory. (10)

Thus, within ten years, wealth-seeking miners had produced, as a by-product, two important historical developments. First, they had laid out and established all the Mountain States. Secondly, they formulated, maintained at gunpoint and fostered the prior appropriation doctrine of water use in the West based on the theory of "first in time--first in right."[1]

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[1] The doctrine arose from the rule developed by miners with respect to mining claims. Water was essential to the working of claims and the first in time to put water to beneficial use was adjudged to have exclusive claim, regardless of riparian values. The custom became law through court sanction. In an early California case, the State Supreme Court said, "Courts are bound to take notice of the political system and social condition of the country, which they judicially rule. ...a system has been permitted to grow up by the voluntary action and assent of the population, whose free and unrestrained occupation of the mineral region has been tacitly assented to by the one government (the United States) and heartily encouraged by the expressed legislative policy of the other (the State of California). If there are, as must be admitted, many things connected with this system, which are crude and undigested, subject to fluctuation and dispute, there are still some which a

Interspersed between and overlapping the miners and farmers were the fabulous and legendary cattle ranchers. In the brief period between 1865 and 1885, the ranchers moved onto the great plains; opened the prairie and its grasses to beef and feed crops; became caught in a vast web of financial speculation that reached across the ocean to England and the Continent; and finally and climactically, found themselves transformed by characteristic great plains drought into farmers of fenced land tending high-priced animals requiring scientific care.

Possessed of wide open spaces, magnificent grass range and horses, Texas after the Civil War became the breeding ground for beef cattle needed by the growing eastern population. The feeding grounds of the mid-central and north-central States were found highly useful for growth. Railroads and Gustav Swift's refrigerated railroad car in 1870 opened the way to bring slaughter houses west of Chicago to Kansas City, St. Joseph, Omaha and Sioux City.

During the twenty years, the build up of cattle on the range continued, fluctuating with economic conditions. The speed of the development was phenomenal. In 1880, central and eastern Montana was largely uninhabited. By 1883, 600,000 head of cattle fed in the range, and the cowboy had come to stay. Crowded range conditions coupled with highly speculative land operations involving eastern and foreign capital, railroad boomed towns and the gradual application of barbed wire fence (first sold in 1874) opened the way to disaster conditions. Drought and the hard winter of 1883 pushed speculative rancher and absentee owners over the financial cliff. In the wake of the

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universal sense of necessity and propriety have so firmly fixed as that they have come to be looked upon as having the force and effect of res judicata. Among these the most important are the rights of miners to be protected in the possession of their selected localities, and the rights of those who, by prior appropriation, have taken the waters from their natural beds,...." (33, pp. 6-7) disaster it became clear, according to Webb (34), that a new set of facts had to be considered. These were that ranchers would have to operate under a system of purchased or leased fenced pasture; that scrub or longhorn cattle had to be replaced by better cattle grades; that the new blooded Hereford bull, costing between $100-$500, needed to be sheltered, protected and fed to protect the investment; that range had to be protected and part saved for winter feed.

These latter points meant that fences and water supply had to be established. Barbed wire was available for fence, relatively easily put up and practical for the big animals. The problem of water supply was largely solved by the drilled well and the windmill for much of the great plains country where no surface water was readily available and where summer and early fall water was far from assured at best.

The farmer entered the frontier, and closed it, hard on the heels of the rancher. Favorable land laws, the railroad, cheap barbed wire and the windmill made possible the farm occupancy of the "Great Plains." But these plains were not the prairies of Ohio, Indiana, Illinois and Iowa. Their special characteristics demanded special treatment. Yet fundamental knowledge about these characteristics had to await scientific examination by men equipped to see the region objectively. These persons, beginning about 1867, gradually began to piece together the true character of the land. But the application of their findings was to be debated, delayed and discouraged; and major steps were not fully taken to meet the basic conditions of land use in this new country until the 1930's and some remain awaiting accomplishment today.

Webb states the characteristic of the Great Plains[1] is the constant and persistent search for water. This was and continues to be the apt description. The region abounds in soil of high fertility. Except for isolated areas, the available water cannot meet the demands of the land and the people. Precipitation, varying from twenty inches annually down to six or eight inches or less in the extreme case, could not support a form of agriculture with which the farmers were familiar. However, as population moved west, technological developments made possible a form of agriculture--variable and of the boom-and-bust variety--but sufficient to hold out enough promise to land-hungry farmers to cause them to stake a homestead.

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[1] Including, actually, not only the plains country west of the 98th meridian, but the intermountain and desert regions to the maritime climate of the Pacific Coast.

Well drilling equipment, quantity production of windmills, and farm equipment adaptable to level prairie lands, provided the under-pinning to the western farmer. Developed largely for railroad use following the Civil War, Fairbanks Morse Pump Company and other firms opened the way to well drilling and pumping equipment. Depths as much as 300 feet were overcome by small step lift through valve arrangements and a vertical shaft operated barrel.

The lift mechanism was powered by windmills, that ubiquitous piece of machinery that was to be seen on the horizon literally without end. Shipped broken down, easily assembled, interchangeable parts, durable minimum material for cheap transportation, simple lubrication and self-governing for wind direction and speed; the machine was ideal for those who had to live with intermittent flowing streams, long drought and few rivers and creeks separated by great distances.

The windmill, Webb summarizes, came into general use after the Civil War. That, together with the invention of barbed wire, which could be used effectively to isolate watering holes and points, was first used extensively by the Union Pacific Railroad. Other railroads followed the path of the Union Pacific, and later became the chief reliance of cattle and sheep men grazing the upland country. This invention, old, commonplace, and somewhat obsolete, today provided a truck farm for the farmer, especially during the drought, and brought a touch of luxury into the prairie homes. "The windmill mitigated the thirst of the Great Plains but did not assuage it. The thirst for water had to go on." (34, p. 346)

The search for water was to be satisfied by adopting the techniques as old as man's written history. Irrigation, practiced first by the Spaniards in the Southwest as a communal enterprise, was followed by the Mormons as an activity of the Commonwealth of the Church. Later, as farmer after farmer moved onto the land and diverted water as individuals, the available supply could not meet the demand. The short supply forced individuals to cooperate and led to the formation of social institutions--irrigation companies, districts and associations. Thus, the land, water and climate largely was responsible for impressing a social environment on the people.

It soon became obvious that the control of the land would rest with those in control of the water and at an early date applications had been made under law, such as it was, for the important water sources. To the people on the land, the land-water relationship was clear. It was less clear, however, to the Congress. The various acts--the Pre-emption Act, the Homestead Act, the Timber Culture Act, the Desert Land Act--had all aimed at opening the western land to the people.[1] For the Great Plains area, however, the acts tended to fail in their aim of stimulating permanent settlement by the inability of the Congressional enactments to arrange for the disposal of water concurrently with the disposal of land.

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[1] The highlights of the important acts in the development of land settlement policies in the West included: the Homestead Act of May 20, 1862, providing for the acquisition of 160 acres of land by each individual farmer; the Desert Land Act of March 3, 1877, making available 640 acres of land at 25 cents per acre as irrigation was initiated within three years; the establishment of the United States Geological Survey on March 3, 1879, Clarence King first Director; Forest Reserve Act of 1891 establishing the beginning of the

The conflicts between the social institutions practicing irrigation under law forced States to greater efforts in the resolution of the conflicts and to provide other social institutions capable of bringing about reconciliation. State actions included the establishment of legislative directives governing the organization of irrigation associations and districts, administrative organizations to promulgate rules and regulations for water allocation and the establishment of police authority to maintain surveillance and control over amounts of water used.[1]

Ultimately, the scale of operations and legal involvements, especially where interstate effects occurred, made the problem one of concern to the Federal government, as well as of direct concern to the large Federal landholding agencies.

The Federal government did not take on new responsibilities in western irrigation programs rapidly or without due and lengthy deliberation. When viewed carefully, Federal action in this, as in many other fields, appears

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reservation movement, under which President Harrison set aside thirteen million acres of forest land; the Carey Act of 1894, earlier the Morrill Act of July 2, 1862, had set aside thirteen thousand acres of land for each Senator and Representative then in Congress for the purpose of endowing at least one agricultural college. This has resulted in the establishment of 69 land-grant colleges so important to the agricultural, land and water research developments of today.

[1] An important State act, a forerunner of similar acts in other States, was the Wright Irrigation District Act of California, 1887. This act brought vast acreages under irrigation under sound amortization programs.

Note: It should be noted that the basis of actions in private development tended strongly and generally to be under programs on a sound fiscal basis. Government aid was accepted in the form of grants of land to stimulate development. This aid, while not accepted as such, had important social welfare concepts. These early demonstrated the ability of this Nation to move in the direction of the land policy acceptable to and for the benefit of the general public. This program should be related to current day's problems of land reform in other countries.

as a slow deliberate action created by the press of circumstances and the presence of an acute problem which was not capable of being solved adequately through other governmental units of the Federal system.

As the farmers moved into the West through the mid-nineteenth century, they expected eastern climate and farming methods to apply. By 1866, Congress, while not entering the field of granting water rights, did grant water owners the right of way over public lands for the construction of ditches and canals. By 1877, the Desert Land Act, of questionable value to the individual farmer, was viewed by the Congress as promising valuable aid. Unfortunately, many hold that the aid redounded to large operators and to the benefit of monopoly formation.

The key that was lacking in the development program in the arid West was a thorough understanding of the scientific basis on which life, both man and domesticated animals, could be established. The initial break-through came about through the report of Major John Wesley Powell, Lands of the Arid Region, in 1878.[1] (16, 34, 35)

Powell set the dividing line for successful agriculture at the isohyetal line of twenty inches of rainfall, approximately the 100th meridian. He divided the land and the area west of the 100th meridian, but primarily in the mountainous areas, into three classes: (1) irrigable lands along benches and banks of rivers; (2) forest lands in the higher altitudes and on the mountain cover, and (3) pasture lands between the irrigated valleys and the forested mountains.

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[1] Between 1867 and 1879, four major surveys of the West were undertaken. Clarence King, the first director of the Geological Survey, investigated land along the 40th parallel from 1867-78. Dr. Ferdinand D. Hayden carried out surveys under the Geological Survey in Nebraska and Wyoming during 1867-78; Lt. George M. Wheeler surveyed the land along the 100th meridian 1872-79 and Major J. W. Powell surveyed the lands of Utah, Nebraska and Arizona during 1869-1878.

Powell early recognized that irrigation required much labor and capital beyond that available through individual enterprise. He understood that water storage facilities would be required to hold water during maximum flow periods for use during time of minimum flow, and that storage would have to be maintained in the upper regions, rather than on the plains.

In a bill drafted for the Congress, Powell included these major points: provision for nine or more qualified homesteaders to form an irrigation district and to govern themselves within the general laws; defined irrigable lands as being 320 acres or more in extent, for which water was accessible; recognized the capabilities on irrigated lands by allocating a limit of eighty acres to each person; established the right of water to inhere in the land and of that right to pass with title of the land, with a proviso that such rights were to lapse if water was not used in a five-year period. Powell was not concerned about land monopoly. If a plan could be devised whereby water rights were to be distributed equitably among farmers, it was his view that this would do much to prevent monopoly.

The economic basis for life in the West in Powell's view was the development of irrigation. Such developments would be possible only through proper financing, construction and operation of irrigable areas. Arbitrary political subdivisions established by man would not be suitable to these fundamental needs. The logic of the West demanded that governmental units be established consonent with the hydrographic basins, thereby recognizing the realities of life in the arid country. Powell outlined the major problems that had to be considered in the development and opening of the West. These were: (1) the redemption and reclamation of one hundred million acres of land; (2) the establishment of suitable laws to properly distribute the land among the people; (3) the division of waters between the States; (4) the basis for the distribution of water to be the amount needed to "fertilize his (the farmer's) field;" and (5) grass lands to be fostered and maintained between the irrigated lands and forests on the mountains and valley sites to be protected; (6) mineral deposits to be kept ready for development by industry and entrepreneurs; and (7) water power to be sought and used.

During 1888-90 and 1891, Congress instructed the Geological Survey, of which Powell had by that time become Director, to survey and mark out irrigable lands, reservoir sites, and canal routes, and to recommend them for reservation by the Federal government for these purposes. Characteristically dynamic, Powell followed the Congressional mandate and marked out 127 reservoir sites and thirty million acres of irrigable land for the reserves. Characteristically also, Congress was disturbed over this vast effort, and in 1890 acted only to reserve reservoir sites, and in 1891 to reserve only those lands needed for the construction and maintenance of reservoirs.[1] (32)

During this period and immediately thereafter, Congress passed the Carey Act, ceding to the States of Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington and Wyoming one million acres each of land within their boundaries. (Another one million acres was again granted in 1908.) This plan, like the earlier plan adopted and applied to eastern States to stimulate the reclamation and drainage of swamp lands, had as its purpose the granting of power to stimulate and develop irrigation to the States. Here again was a clear position on the part of the Federal government to refrain from entering into local situations; of hopefully looking to the States to carry out national policies under a general authority; of using Federal authority with caution and with respect for the Federal system as viewed at that time. This act, together with the Desert Land Act, did not as a whole, measure up to expectations. Increasingly higher costs kept private developments from occurring. However, about 1/20 of **western** irrigation started as Carey Act land; thus, the act was not a complete failure. The Carey Act still remains in effect, and some work continues to be carried out under its authorization.

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[1] The authorization read, "For the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation--and for the selection of sites for reservoirs and other hydraulic works necessary for storage and utilization of water for irrigation--the work to be performed by the Geological Survey..." and, "for gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing water resources.

The Carey and Desert Land Acts were not the only steps taken by the Federal government to insure that it would not become the sole owner, operator and developer of public lands for agriculturals purposes. The Act of July 26, 1866, granting rights of way over public lands for ditches and canals left "to local customs, laws and decisions of the courts" the development of irrigation. The Federal government thereby surrendered any control which it might have had over the useof waters of non-navigable streams of the seventeen western States for irrigation. The Act provided that all irrigation must be carried on under State laws, and this action was subsequently confirmed by the Supreme Court and has remained in force ever since. (36)

TABLE 6

CONGRESSIONAL APPROPRIATIONS FOR INVESTIGATIONS
RELATING TO IRRIGATION

Investigation	Years	Amount
Surveys for dam sites and irrigation projects-- Geological Survey	1888-1890	$ 350,000
Gauging streams	1895-1911	357,000
Construction of ditches and related assistance-- Office of Indian Affairs	1894-1901	700,000
Irrigation investigations--Department of Agriculture	1890-1901	198,000
		$1,605,000

With the passage of time and population build-up in the plains, public interest grew apace. The drought of 1890 focused public attention sharply on the West and the related irrigation problem. A crusade for irrigation took form and meaning through the work of William Smythe of the Omaha Bee. Following the development of several conventions in western Nebraska, Smythe arranged for the first national irrigation congress which met in Salt Lake City in 1892. While no Federal involvement was indicated at the initial meeting of the congress, its succeeding conventions up to 1900 began to consider irrigation in terms of a problem having national interest. In the interim, Senator Carey of Wyoming had in 1894 successfully led the enactment of one of the earlier positions of the National Irrigation Congress, allowing States the grant of lands and the development of irrigation programs under State policy.

In the interim, and concurrently, the Federal government in 1897 authorized the War Department under the Rivers and Harbors Act of June 3, 1896, to survey the States of Wyoming and Colorado for reservoir sites and appropriated $5,000 for this purpose. In 1897, Captain Hiram M. Chittenden made his report. Chittenden's report digressed from the Powell view in that it recognized new patterns in its advocacy of Federal participation in reclamation projects. Chittenden noted that he hoped his reasons for Federal participation were soundly based on fact. Chittenden's comments on two questions are worth noting in the light of the issues that were then being raised with respect to future Federal participation in irrigation activities.

After agreeing that there were direct and primary motives for constructing reservoirs in the region west of the 100th Meridian, Chittenden inquired as to the proper agency to do this work. He eliminated individuals, since it was obvious that the work required was beyond their abilities. Corporations, he held, were imperfect, could not result in general utilization, and would make water private property. Irrigation districts could not develop a comprehensive system and would not have the resources necessary. Finally, he favored the Nation over the States, stating that:

> Irrigation is interstate in character, and therefore a national problem. Water and forests are directly related; forest control belongs to the national government; therefore water control should also belong to it. Public opinion in the West favors government aid in the construction of reservoirs. The national government is the only agency that could construct a unified system of reservoirs for the entire region; it is the largest landholder in the West; and it alone has means sufficient to carry out the plan.[1]

Answering another of his inquiries as to how irrigation systems would be administered, Chittenden's answer provided the following:

> The government would acquire, own, and control the reservoirs and the right to impound water. It should construct the reservoirs and maintain them. The water should be free to the people and for public works, just as are canals, harbors, and other public works. The government should have the right to close the reservoirs in time of flood or at any time the public necessity demanded it. The waters should be released upon requisition of the proper state authorities in such quantities as may be required, and when released should become subject to such state and local laws as pertain to the waters in the stream in its natural conditions.[2]

In 1897, the National Irrigation Association headed by a new and dynamic leader, George H. Maxwell, (replacing the National Irrigation Congress in 1897) met in Chicago in 1900 and supported resolutions for: (1) a comprehensive system of flood storage and reclamation in arid lands; (2) the abolition of water monopoly; and (3) favoring the policy of making water appurtenant to the land.

By 1900, the issue had become so clear that both the Republican and Democratic parties and the Silver Republicans advocated national aid for the reclamation of land through irrigation in their platforms.

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[1] Walter Prescott Webb, The Great Plains (New York: Grosset & Dunlap, 1931), p. 360, commenting on Captain Hiram M. Chittenden, Preliminary Examination of Reservoir Sites in Wyoming and Colorado, House Document No. 141, Fifty-fifth Congress, Second Session, Serial No. 366, pp. 50-63.

[2] Ibid. pp. 360-1.

CHAPTER V

1900-1960

The most noticeable change at the midpoint of the one hundred years of unprecedented progress was a mounting public awareness of government's abili significantly to aid in seeking solutions to social and economic problems. This awareness, coupled with a strong President, made the first decade of the new century a milestone in human progress.

The viewpoint of President Theodore Roosevelt, the reforms he gained for the people, those he proposed but which were delayed for a decade or two, all were cast in a setting which had been identified philosophically by the line of political theorists such as Bentham, James and John Stuart Mill, Henry George, and--between 1880 and 1900--by Thomas Hill Green in England and William James and John Dewey in the United States.

Green, a rector's son, educated at Rugby and Balliol Colleges, was lecturer in history and Greek philosophy and, prior to his death, Professor of Moral Philosophy at Oxford University. His doctrines, establishing an ethical base for the liberalism of Bentham and the Mills, were stated in 1879-80-81. (12, 37)

Green's philosophy of ethical liberalism, which was to dominate Anglo-American thought for a generation at the turn of the century, aimed to meet the valid objection raised against liberalism, or that, as a one-sided statement of class interests, it, "...stood for a conception of liberty which, in fact if not in intention, amounted to a reckless disregard for social stability and security." He was concerned with the, "moral injustice of a society that withheld from large portions of its members the goods, partly material, but chiefly spiritual, which the culture of that society created.

The major theme of his argument was that the goal of past liberal theory was merely the repeal of obsolete legislation; that the goal of proper liberal thought, he held, should be flexible to meet circumstances and to follow the guidance of moral purposes. Such policies are essentially an effort to open a humane way of living to a larger number of persons.

Green acknowledged that Bentham's utilitarian standard of producing the maximum of pleasure for the greatest number had been highly useful. Building on this principle, he arrived at the conclusion that political institutions are to be judged according to their contributions to the development of the character of the citizens. A liberal government should support a free society, and while it cannot make men moral, it can remove many of the obstacles that stand in the way of their moral development. This means that the State has to interfere in social life in a positive and creative fashion to provide the individual not only with the formal opportunity but with the actual opportunity of doing worthwhile things.

This restatement of liberal thought broke down the rigid lines between economics and politics which had acted to exclude the State from interfering with the operation of a free market. Green believed that a free market was a social institution rather than a natural condition and might require positive legislation to keep it free. Politics and economics are intertwined and, together, ought to contribute to the ethical purposes of a free society.

Where previous liberalism had looked upon the State with suspicion, Green's liberalism, "was a frank acceptance of the State as a positive agency to be used at any point where legislation could be shown to contribute to positive freedom, ...for any purpose that added to the general welfare without creating worse evils than it removed."[1]

In the United States, William James and John Dewey spoke of a universe responding to man's creative intelligence. The social implications of this new view argued for the destruction of old faiths, whether theological, economic or political. (38, Ch. 2)

Between 1886 and 1890, five important academic journals in the social sciences were founded (Political Science Quarterly, Quarterly Journal of Economics, Annals of the American Academy of Political and Social Science, Journal of Political Economy and American Historical Review). Early, the view of the social scientists was to view the physical and social world as bound by immutable laws. Lester Ward, an early paleobotanist and sociologist, challenged this philosophy. Man, Ward said, was not only the inheritor of change, "he was the creator of it, fully capable of rational planning and social engineering."

Albion W. Small, editor of the American Journal of Sociology, argued, "for more effective research and action for the promotion of the general welfare." Under this banner, articles on municipal reform began to appear before Lincoln Steffens began his "muckraking articles" on the same subject.

The revolution in thought continued in the field of economics. The credo of the American Economic Association in 1885 read, in part, "We regard the State as an educational and ethical agency whose positive aid is an indispensable condition to human progress."

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[1] Although Green justified political regulation of economic activities of individuals, his doctrine was not socialistic. He respected private property and accepted economic inequality as an inevitable by-product of inequity of native capacity.

The law shared, too, in the uprising. Oliver Wendell Holmes, Jr., published, in 1881, his Common Law in which he held that the basis of law was human experience and man's total material and intellectual environment. This practical philosopher, moving later to the United States Supreme Court, was to do much to bring the benefits of the ethical liberalism to the American people.

On the battleground of practical politics, the progressive movement provided the popular support that made possible the transition that the United States made at the turn of the century. While the Interstate Commerce Act was passed in 1887, the Sherman Anti-Trust Act in 1890, and while municipal reform had been underway since 1890, the movement did not become nationwide until after 1901. (39) Many of the goals were those stated previously by the agrarian reformers and the populists. But the effect of the economic crises of the '90's, the depression of 1893-97, shook the Nation thoroughly. No longer was there the conservative assurance that the American system could be counted on to survive as men had known it. The social problems that were common to European industrialization were becoming existent in the American scene.

The "young men" of 1890: Theodore Roosevelt (thirty-two), William Jennings Bryan (thirty), LaFollette (thirty-five), Woodrow Wilson (thirty-four), were to become the leaders of the Progressives. Continuously until 1920, these men were to spearhead a growing campaign, first--against monopoly and political control of the Nation by the growing corporations and trusts, and secondly--to safeguard individual rights and preserve a competitive economic system while recognizing the new organizational adjustments that were in the making as a result of increasing industrialization and the production of vast quantities of goods making possible a better life for the people.

This total intellectual ferment, affecting, as we have seen, every part of society, had its impact on such matters as conservation of resources, public health, and the relationship of government to public requirements involving water in many aspects. The young men that led the age of reform, also produced young men who were, in future decades, to enlarge greatly the scope of government's role in society.

In the decade prior to 1900, the United States had visibly entered a period of reform which, with occasional slowing periods, is continuing. There is no single, special charactistic that can characterize the development that has taken place or that will take place. It has no precedents. It is the fulfillment of the industrial revolution, the upsurge in science and education, the age of material plenty and the beginning of the exploration of space.

The manner with which man has considered, husbanded, and used his water resources, is only one of the many elements that form the total mozaic of American society. The introduction to this section was intended to clarify the broad framework within which the mozaic has developed. The balance of this section identifies the mainstreams of development during the sixty-year period affecting water resources. Those major mainstreams are reflected in four general titles: (1) Conservation, (2) Public Health, (3) Metropolitanism and Industrialization, and (4) Water Resource Development. While some overlapping occurs in approaching the period in this manner, it has the benefit of combining a large number of factors and programs into manageable units.

1. Conservation (16, 32, 40)

As a device to extend the use of limited resources, or to assure a continuing supply for military or economic reasons, conservation had been practiced since earliest colonial days. Conserving fresh water ponds for public fishing, limiting pollution to protect aquatic life, reserving copper, trees for shipbuilding or salt springs were typical applications.

The initial phase of the modern conservation movement stretched through the last thirty years of the nineteenth century. Opening the new lands of the arid and semi-arid West made necessary a careful use and husbanding against waste of the water needed to make the land live. The early surveys, studies and fact-finding that continued throughout the period brought new knowledge and awareness to objective and thoughtful minds.

Knowledge of the devastation of the forests and beauty of the Nation were important factors in the drive by that small group of dedicated men to set aside the uniqueness of Yellowstone for a National Park. The Act of March, 1872, setting it aside, "as a public park or pleasuring-ground for the benefit and enjoyment of the people," was joined seventeen years later by the Act of March 2, 1888, setting aside the first prehistoric site reservation at Casa Grande ruin in Arizona.

Two years later the first general conservation measure was passed. (March 3, 1891) This Act repealed or tightened the laws under which vast acreages of timber lands were disposed of; made more strict, land developments under the Desert Land Act; and empowered the President to set aside as forest reserves public lands covered with timber or undergrowth, whether of commercial value or not. This last provision, known as the Forest Reserve Act, was used by President Harrison in 1891 to establish the Yellowstone Forest Reserve, and later by President Cleveland to set aside an additional twenty-five million acres of forest preserve.

The establishment of the technical services in government as the Geological Survey, Biological Survey (1896) and a Forestry Branch in the Geological Survey (1897) helped set the stage for the strong conservation effort of President Roosevelt. Not only were technical facts being accumulated; more importantly, a cadre of trained scientists following in the footsteps of the Powells, Crittendens, Kings and others, with understanding of the workings of nature and the encironment, began to play their staff and study roles, so essential to considered policy formulation.

Generally, in reviews of the Nation's development, the Federal government has been cast in the role of a highly conservative entity, acting under a "hands off" policy. Despite the fact that government involvement and innovation were not well developed throughout most of the Nation's history, there are numerous illustrations of innovations that were undertaken under critical stress. Aid to canal building when waterway transportation was needed; aid to establishment of manufacturers; land grants to railroads to bridge the continent; and land policies, geared first to income but later to land settlement reflected government action. These actions were in tune with the general view of government at the time, yet cannot be fully characterized as "hands off."

Thus, not only were the times right from the standpoint of a crisis situation in forest resources, but the reform movement, the intellectual ferment of the period, the knowledge of the scientific relationship between western water resources and the development of the land, and the relation of forests to water conservation all added up to support a dynamic government action program, in contrast to the past, sponsored by President Roosevelt. Of equal importance was the basic philosophy underlying the Rooseveltian period--to return the government back to the people; to assert the democratic process of power in the people's hands.

The Roosevelt conservation reforms were led by the early introduction of the Newlands Bill in the Congressional session of 1901. Thirty Senators and Representatives of the seventeen western states approved the plan whereby a part of the receipts from public land sales would be used to construct dams and reservoirs for irrigation purposes. This National Reclamation Act was passed in 1902 with the help of the President, who had succeeded to the high office from the vice presidency upon the assassination of President McKinley in the Fall of 1901.

The Newlands Act brought the government into reclamation works directly after, as we have seen, most of the easily irrigated, more economic areas had been developed. Powell's injunction, along with Crittenden's, of the need for large-scale works in the headwaters demanded economic forces and political arrangements beyond local or individual or corporation control. Here, as in the forest situation, the Nation again was forced into action due in no small part to the critical state of affairs. Following the clearing of timber for agricultural development in the Ohio Valley, in the Alleghenies and in the East, timbering by 1850 began to move into the Greak Lakes pine forests. Most of these were cut by 1900 and beginning about 1880 southern timber began to be utilized. This area was largely exploited by 1910. The need to safeguard the water for the plains, the remaining timber resources, and the highly unique scenic areas became a necessity by Roosevelt's time.

In his first message to the Congress, Roosevelt stressed his conservation views and in 1903 he appointed a commission to study the remaining public lands. In the seven years of office, he added almost 150 million acres to the forest reserve and through Gifford Pinchot, the Nation's chief forester, managed to reserve over twenty-five hundred power sites in spite of Congressional opposition, by declaring them ranger stations.

The years 1907 and 1908 climaxed the efforts of the President. So wide an impetus did he give to the idea of conservation of natural resources that forward motion, instead of being damped with time, has increased until it has become a common national value. The Winter of 1907 produced the philosophic statement of the conservation idea ("wise use" determined by economic, social, aesthetic and moral considerations; its goal, "the greatest good for the greatest number for the longest time"); a strong statement to the Congress concerning the waste of natural resources; and the appointment of the Inland Waterways Commission. The Spring saw the development of the idea of the Governors' Conference; approval by the President came in October and the date of the Conference set for May, 1908.

The President reflected the composite tasks associated with water resources development that had accrued since 1865; to navigation he added the control of floods; for the West he considered the problems of irrigation water in its relation to land, forests and settlers' homes; he brought the new knowledge of hydro-electric power into focus as a national resource and a national responsibility; in keeping with the raging water-borne epidemics of the period and early studies of the United States Public Health Service, he added his concern for water pollution and water purification; and he gave new life to the nearly outmoded inland waterways by visualizing a network throughout the Mississippi heartland, along the coasts and on the Columbia. Taking all these into account, he charged the Inland Waterways Commission in March, 1907, "to prepare a comprehensive plan for the coordinated use of the water resources of the country," which would take into consideration, "the relations of the streams to the use of all the great permanent natural resources and their conservation for the making and maintenance of prosperous homes." The Commission report in February of 1908 laid out the modern premise of treating every river system as a unit from its source to its mouth. It also laid the basis for including, in any plans established for navigation of inland waters for interstate commerce, consideration of pollution control, floods, power, irrigation, drainage and all other uses and benefits to be derived from their control.

Here again was Powell's hydrographic unit, on an enlarged basis. Here, too, were the expanded views of Crittenden. Local interests, the Commission said, should be considered in relation to regional and national interests. Thus did the Commission initiate the basis of justifying a storage facility high on the Missouri or Monongahela for benefit of flood control on the lower Mississippi. Ideas grew slowly; the Commission pulled the separate pieces together and provided the Nation the opportunity to view the unified whole of the water resource program that it would have to face in the ensuing decades.

The ability of the office of the President to influence and educate the public and public and private leaders is best illustrated in the Governors' Conference of 1908. Called by the President to stimulate the Nation's thinking about the conservation of the Nation's resources, it resulted in making the subject a national public issue. In opening the Conference, the President marked the subject as being of extreme importance, second only to morality; noted that the main characteristic of civilized men was their ability to exercise foresight--to plan ahead. On matters of responsibility between the Federal government and the States, he held that, "If the matter is such that the State itself cannot act, then I wish, on behalf of the State, that the National Government shall act." The difficulty of carrying out this policy has, in subsequent years, always revolved not so much about whether the State can or cannot act, but about whether the State will act. For Roosevelt, this was not merely a philosophic problem. He acted on a great many issues; railroad supervision, pure food control, control of monopolies and corporations and on the national government's concern for resources.

The Governors' Conference included, among its recommendations: (1) that the President call future similar conferences to insure continued cooperation between the States and the Federal government; (2) that State commissions be formed to cooperate with a similar Federal commission to inventory and appraise the condition of the Nation's resources; (3) that laws looking to the conservation of water resources for irrigation, water supply, power and navigation be enacted.

Following the recommendation, a joint conservation conference had presented to it in December 8-10, 1908, a summary of a three-volume report showing the conditions of the Nation's waters, forests, lands, and minerals. Among its recommendations it urged treatment of watersheds as units and approved the broad plan of the Inland Waterways Commission for waterway development under an executive board or commission appointed by the President. On January 22, 1909, he transmitted the report to Congress with a request for appropriations to provide follow-up in several areas, which was largely ignored.

With the new Congress in 1909, and a new President, the Congress created a Commission of their own (The National Waterways Commission) to continue studies on water transportation and the improvement of waterways. No official executive branch of government representation was appointed to the Commission. A preliminary report was submitted in January, 1910, and a final report in March, 1912. Recognizing the practicality of reservoirs for flood control, navigation and power, the report noted the fallacy of expecting the same reservoir to be fully effective for all three purposes. Compromise for maximum net benefit for multiple purposes was still in the future.

Another conclusion of the Commission touched upon that which Chief Justice Marshall had partly settled some 86 years before: that Federal activities are limited to the control and promotion of navigation; that the Federal government had no constitutional authority to engage in works intended primarily for flood control or power; that any flood prevention work can only be undertaken if associated with navigation.

On the matter of Federal authority over navigable waters, the Commission held that the Supreme Court had clearly established that, "the authority of

Congress reaches to the remotest sources in the mountains of every navigable stream. ... There should be no misunderstanding as to the extent of the authority of Congress...to exercise its full powers. With the increasing unity of our national life and the growing necessity of securing for human needs the maximum beneficial use of the waters of every stream, it will become increasingly necessary to treat every stream with all its tributaries as a unit. In the nature of the case so comprehensive a policy could be successfully administered only by the Federal government, and consequently the eventual desirability of Federal control is easy to predict."

The Commission pointed out that by withdrawing water power sites and by rules over public lands through the Departments of Interior and Agriculture, the government had already taken steps to control the development of water power. Further recommendations regarding power were followed closely in provisions later adopted in the Federal Power Act of 1920.

President Taft, a genial conservative, yet keen in his support of Rooseveltian ideals, regained the power that Roosevelt had lost; that of removing public domain lands by executive order, and used the power energetically. The development of the Salt River in Arizona moved toward completion during the Taft administration with the completion in 1911 of the large Roosevelt Dam. Capable of watering 700,000 acres of fertile land, the project gave great impetus to irrigation projects by the Reclamation Service.[1]

Two concepts of high significance were sharply presented during the Taft administration, neither of them directly connected with natural resources; yet both have had a major role to play in government's role in resource development.

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[1] For notes regarding the Roosevelt Period, Commissions, etc., see bibliographical references (5), (16), (38), and (40).

The first was his actions with respect to a graduated income tax. Mowry (38, p. 63) comments that Taft was responsible for perhaps the most profound reform passed in the course of recent American history and that it is almost impossible to see how most of the social legislation passed since 1912 could have been financed without the income tax. The absence of the tax would have meant complete frustration to any government seeking to redistribute income in an orderly fashion.

The tax was started on its way by the President by, first, the defeat of his proposal for a graduated inheritance tax; second, by a proposal by Senators Borah (Idaho) and Bailey (Texas) for a graduated income tax, which the Supreme Court in 1895 had found unconstitutional; third, seeking a suitable compromise and not wishing to embarrass the Court, the President proposed a compromise of a corporation tax and the initiating of a constitutional amendment legalizing the income tax. The President later, when the issue was before the States, wrote friends in the Ohio legislature urging support so a Federal tax bill could be written. The income tax itself was passed later, during the Wilson administration.

The second concept of significance was the President's actions to strengthen the efficiency and economy of the government. In his first message to Congress in 1909, Mr. Taft stressed economy and by executive order required all budget estimates be submitted to him prior to submission to the Congress. In 1911, he appointed a Commission on Efficiency and Economy to carry out a survey of administration organization.

On June 27, 1912, the President transmitted to Congress the report of the Commission on the need for a national budget.[1] On June 12, 1912, the President notified all Department Heads that he planned to try out the recommendations of the Commission on budgeting. The Congress resented this action and forbade the submission of budgetary estimates other than according to customary usage.

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[1] U. S. Congress, House Document No. 854, 62d Congress, 2d Session.

Responding to the opposition of the Congress, Mr. Taft outlined the basis for his request in a letter to the Secretary of the Treasury and other Department heads. On September 19, 1912, he wrote, "Under the Constitution the President is intrusted with the executive power and is responsible for the acts of heads of Departments..., and can use them to assist him in his constitutional duties, one of which is to recommend measures to the Congress and to advise it as to the existing conditions and their betterment.... If the President is to assume any responsibility for either the manner in which business and government is transacted or results obtained, ...he cannot be limited by Congress to...information...that branch may think sufficient for his purpose. In my opinion, it is entirely competent for the President to submit a budget, and Congress cannot forbid or prevent it. It is...within his duty and power to have prepared and submit to Congress and to the Country a statement of resources, obligations, revenues, expenditures and estimates in the form he deems advisable. And this power I propose to exercise."[1]

On February 26, 1913, the President submitted a consolidated budget to the Congress which they promptly ignored. By Executive Order, on March 4, 1913, the Division of Efficiency was formed in the Civil Service Commission. Three years later it was made an independent establishment as the Bureau of Efficiency.[2]

In 1917, the Congress authorized the Bureau of Efficiency to report to Congress reorganization needs of the Federal departments and later that year its powers were enlarged to investigate duplication.

In bills submitted in 1919-1920-1921, the Congress considered the establishment of a national budget system. On June 10, 1921, the President approved an Act creating the Bureau of the Budget, and the General Accounting Office.[1] As a management device, we will have occasion to discuss the wide implications of this action in later sections.

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[1] W. Brooke Groves, Basic Information on the Reorganization of the Executive Branch, 1912-1948. Public Affairs Bulletin No. 66, February, 1949, Library of Congress Reference Service.

[2] 39 Stat. 15, 64th Congress, 1st Session, 1916.

From Taft to Franklin Delano Roosevelt only a few new major elements entered the conservation work plan of the Nation. Those were elements that stood apart from project activities approved by Congress annually for rivers and harbor improvements, navigation and ancillary flood control and reclamation, such as the agriculture extension service, and the new developments in scientific agriculture in managing soil and water. Considerable time had to pass and emergencies arise before the full scope of the recommendations of the Roosevelt Conferences and Commissions could be placed into effect.

The National Waterways, in their final report of 1912, had explored the manner in which the Federal government might exercise control over the vast resource made available by the invention of the electric dynamo. Between 1912 and 1920 monopoly practices in the electric power industry, bribery and corruption associated with such efforts and the grasping for power sites brought about renewed demands for controls of the energy represented in falling water. (41, pp. 49-51) The Ballinger-Pinchot controversy in which Interior Secretary Ballinger was accused of transferring important water power sites in Montana and Wyoming to private interests contributed importantly to this development. (40, p. 105) (43) The climax was reached in 1920 with the passage of the Federal Power Act, extending Federal control over water power development in navigable streams. (40, p. 105)

The pre-emption and homestead laws had allowed private acquisition of water power sites up to 1896. From 1896 to 1920, licenses were issued by various cabinet officers, and grants on navigable streams required a special Act of Congress. (43, p. 23)

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[1] P. L. 13, 67th Congress, 1st Session.

The Act of June 10, 1920 created a commission composed of the Secretaries of War, Interior and Agriculture. Water power on navigable streams and public lands were subject to control of the Commission through authority to issue licenses up to fifty-year period.

In passing the Federal Power Act, Congress repealed in a provision of that Act, a 1917 Act establishing a Waterways Commission. This Commission had been given the authority sought by conservation supporters for over ten years. It provided for coordination of all water interests in government; investigations were to consider all water uses; and in reports to the Congress, the Commission was to, "...formulate...a comprehensive plan or plans for the development of waterways and water resources of the United States...." (44, p. 10) The basic responsibility of the Commission was to give meaning to Theodore Roosevelt's contention that every drop of water should be profitably used on its way to the oceans.

The inclusion of portions of these responsibilities in the Federal Power Act led House conferees to reject a Senate Amendment preserving the Commission but broadening its membership. One of these, the inclusion of responsibility to tie power requirements to a comprehensive water development plan, has seldom if ever been utilized by the Federal Power Commission. (44, p. 10)

The Federal Power Act, together with the Mineral Leasing Act of 1920 represented the two important conservation legislation efforts during the Woodrow Wilson administrations.

The Harding administration added little of substance to water conservation.

The Congress, at the start of the Coolidge administration in March, 1925, authorized the Corps of Engineers and the Federal Power Commission to formulate, "...general plans for...improvement of navigation...in combination with... development of...power, control of floods and needs of irrigation."[1] The list of surveys reported to the Congress under this Authority was printed in House Document 308 (69th Congress, 1st Session). These became the basis for continued studies and, with revision, have provided the basis for most of the Nation's river development programs. (44, p. 13)

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[1] Section 3, River and Harbor Act of March 3, 1925. (43 Stat. 1186, 1190)

President Hoover, a professional geologist and engineer, had a substantial knowledge and interest in natural resources. During his tenure, he added about three million acres to the forest reserves and supported the development of Boulder (later Hoover) Dam[1] as the first major irrigation project to share the use of stored waters with other purposes including flood control, navigation, power and other beneficial uses.

The Roosevelt New Deal brought a revolution of concept and action to the issue of resource conservation. Instead of holding to what remained of resources after acquisition and use by private interests, the Roosevelt period aimed at rebuilding and reclaiming the resource base.[2] A complementary purpose, that of overcoming the deep depression of the late Twenties and early Thirties, shared the reason for the massive efforts then undertaken.

Major water-related Acts during the 1930's included (1) the several relief acts which provided funds for reforestation, prevention of flood and soil erosion, creation of civilian conservation corps; (2) public works program (which included Grand Coulee on the Columbia, Fort Peck on the Missouri and others); (3) the Act creating the Tennessee Valley Authority; (4) major advances in flood control through Flood Control Act of 1936; and (5) related land control measures helpful to stabilizing land use and water flow. Executive orders provided for withdrawal of lands for Bonneville and Fort Peck

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[1] Boulder Canyon Project Act, December 21, 1928.

[2] For a summary of major Acts of Congress and Executive Orders pertaining to conservation, see Stuart Chase's "Rich Land, Poor Land", pp. 302-304.

Dams and reservoirs and extensive water power surveys by the Federal Power Commission.

The vast effort during the 1930's stimulated and extended most areas of water resource development. In addition, it developed a resurgence of effort in the old line agencies as Geological Survey, Public Health Service, Reclamation Service, Forest Service and Biological Service (later Fish and Wildlife Service). In the main, Congress enacted the new statutes within the existing framework of agencies and their functional responsibilities. Thus, extensive developments in flood control were contained in normal flood control acts, reclamation in Interior Department legislation, and soil and water control in Agriculture Departments acts. One of the exceptions to this was the inclusion of flood control responsibilities for the Department of Agriculture in the Flood Control Act of 1936.[1]

By 1938, the bulk of conservation policy advances had been made. Preparation for war and the war years limited new policy developments and placed great strain on the Nation's resources.

The post-war years brought new developments in three water resource areas; a major development in economic policy of great significance to resources generally, including water; and a new plateau of expenditures for programs under already established policies in navigation, flood control, irrigation, power and related water functions. In addition, policy review considering organization; the role of the Federal government, the States and local agencies; and coordinated regional planning extended the thoughts debated in the 1910's, the 1920's, the 1930's into the 1940's and 1950's at an ever-increasing rate.

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[1] The development of flood control responsibilities of the Department of Agriculture leading to the Watershed Protection and Flood Prevention Act of 1954 is discussed in detail under the following section of this chapter dealing with Water Resource Development.

The three major policy developments were in the fields of (a) water pollution control (Public Law 845, the Water Pollution Control Act of 1948); (b) watershed protection (Public Law 566, the Watershed Protection and Flood Prevention Act of 1954); (c) municipal and industrial water supply (the Water Supply Act of 1958, Title 3 of the Flood Control Act of 1958).[1]

On the economic front, the Full Employment Act of 1946 marked the acceptance of a national policy holding that the Federal government would no longer sit idly by in the event of national economic disability; that the public agencies shared in the burden of providing, stimulating or otherwise safeguarding employment opportunities; and that the power of government would be used toward this end. In the resource area, benefits have accrued in the development of a sharper view toward the Nation's resources as an important basic element upon which rests the Nation's strength. The recognition of needs in the reports of the Council of Economic Advisers to the President and the translation of the indicated needs into action programs has been highly beneficial in keeping before the public the resource needs of the Nation as well as providing a general basis for Congressional action for satisfying those needs.

Partly as a result of wartime expenditure habits and increased income from higher taxes; partly as a result of a public policy geared to meet public needs of a rapidly growing population; partly as a result of an ever-increasing and continued demand for a better life, greater economic opportunity and great industrial expansion, the Nation since 1945 has budgeted great sums of money for capital improvements in the water resource field. Inland and coastal navigation improvements have increased; flood control demands have been stimulated by great developments into the flood plain and ever greater losses during flood periods; power associated with flood control and irrigation developments has stimulated regional development; reclamation projects have brought into production self-contained and sustaining economic islands in the semi-arid, drought-ridden great plains, larger sums have been devoted to control of water where it falls in the land; pollution control, brought to the forefront as a conservation measure as a consequence of added population, urbanization, industry and agricultural developments, has added new costs to national, State, and local budgets; and water supply for cities has developed greatly in an attempt to overcome the backlog of deficiencies resulting from the war years of the 1940's.

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[1] Pollution control and water supply policy will be discussed in detail in the following section on Public Health, this Chapter.

As reported by the Twentieth Century Fund, public expenditures, primarily Federal, for conservation and development capital outlays averaged $86 million per year from 1920-1932; $555 million per year from 1932 to 1941; $261 million per year from 1942 to 1947; and $802 million per year from 1948 to 1952. (45, pp. 1009-1014)

During the decade of the Fifties, the Bureau of the Budget reports Federal expenditures for water resource development averaged $916 million per year for the years 1950-1960. (46, p. 3437)

While the two sources of data on expenditures are not fully comparable, they provide a satisfactory "order of magnitude" basis for viewing the increase in dollar volume of construction. Compensating for increased prices in the post-war period, the levels during the past decade in real construction may not be much greater than those of the public works period 1932-1941.

Throughout the sixty-year period, a principal aim, reiterated again and again, has been the preparation of coordinated plans for the development of the water resources of the Nation's river basins. The study commissions during the period of 1907-1909 clearly enunciated the principle. By 1917, the principle found its way into legislation[1] and, by 1920, had been repealed in the Federal Power Act of that year.

Executive Branch reorganization was also sought as a means of bringing the multi-water functions of government under coordinated development. An early action along this line was undertaken during the Harding administration.[1] A recommendation by the President, considered by the Joint Committee on reorganization, to transfer all civil works functions of the Army Engineers to the Interior Department was not approved by the Committee.

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[1] Act of August 8, 1917, establishing the Waterways Commission. 40 Stat. 250.

An important step toward coordination of several functions and at least two agencies was that provided by the Congress in authorizing the "308" reports. This had the effect of initiating basin-wide surveys over the entire Nation for navigation, flood control and power. In addition, these reports could include recommendations for associated irrigation developments. One favorable aspect of these reports has been their evolving character. As time progressed, the "308" reports, responding to Congressional policy developments, have expanded to include other functions in addition to their original primary purposes. While these reports have not at all met the need for coordinated basin-wide plans, they provide an important milestone, are today very effective and may prove to be, if Congress so decides, the chief device for comprehensive development.

During 1932, further attempts of President Hoover to reorganize and consolidate water functions under the Department of the Interior[2] were turned down by the Congress.[3]

The depression years brought forward new studies and efforts to improve and extend water resource planning. In 1934 the President's Committee on Water Plan[4] reported a priority listing of drainage basins which warranted detailed comprehensive planning studies. Another committee (Mississippi Valley Committee) under instructions from the Public Works Administration developed a broad plan[5] for the Mississippi Valley. The plan brought new recognition for the need to consider the social and economic relationships of a basin-wide water development plan.

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[1] S. J. Resolution 191, 66th Congress.

[2] House Document 493, 42nd Congress, 2nd Session.

[3] House Resolution 334, 72nd Congress, 2nd Session.

[4] Development of the Rivers of the United States, House Document 395, 73rd Congress, 2nd Session.

[5] Report of the Mississippi Valley Committee, Public Works Administration, October 1, 1934.

Subsequently, the President established the National Resources Board; replaced it by the National Resources Committee in 1935, and instructed its Water Resources Committee to determine, for each drainage basin, (a) principal problems; (b) an integrated water development pattern to solve these problems, and (c) to establish a list of prospects with priorities.[1]

The efforts of the National Resources Committee during its life were extensive and impressive. The Committee could not, however, count any success in leaving a permanent improvement in governmental structure to facilitate and further the idea of comprehensive basin-wide planning. At the most its coordinating efforts could be credited with laying the groundwork for organization of the Federal Interagency River Basin Committee in 1943 to carry on similar efforts after the Committee's death in 1942. Its intellectual legacy, however, has provided important support to students of comprehensive water resource planning and the ideas it fostered have found development in other lands beyond the United States.[2]

In 1936 and 1939 reorganization studies were again undertaken, but no positive results affected the status quo of the water resources agencies, the Congress and their Committees.

Following World War II, efforts to deal with reorganization of government and to establish an improved base to carry out the Nation's water development programs intensified. The following table lists the more important studies within both the Executive and Legislative branches of government that have been made from 1947 to 1960.

Notwithstanding the establishment of Policy Study Commissions; Reorganization Studies, Basin Planning Commissions; Review Commissions and innumerable Congressional hearings on a multitude of legislative proposals, as of late

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[1] See Drainage Basin Problems and Programs, December 1936 (Revised 1937) and other reports of the National Resources Committee.

[2] Following World War II, the American Occupational Government in Japan, through its resources section, organized an effective Natural Resources Board as a staff office to the Prime Minister. This Board is operative today.

1960, no substantial shifts in agency organization, agency policy (other than the several aspects noted in the preceding portion of this section), or Congressional policy has developed to facilitate comprehensive river basin planning. The goal established by Theodore Roosevelt has yet to be reached, although those working in the field feel, from time to time, that definitive action might be taken soon, assuming that the trend of events and problem pressure is so great as to make such action essential now.

TABLE 7

SUMMARY OF STUDIES AFFECTING WATER RESOURCE DEVELOPMENT

1. Commission on Reorganization of the Executive Branch of the Government (First Hoover Commission) (1947).
2. President's Water Resources Policy Commission (1950) (Cooke Commission).
3. Bureau of the Budget Review Committee on the Cooke Commission Report (1951).
4. The President's Materials Policy Commission (1951) (Paley Commission).
5. Subcommittee to study Civil Works, House of Representatives, 82nd Congress, 2nd Session (1951) (Jones Subcommittee).
6. Arkansas-White-Red River Basin Study Committee (1950).
7. New England, New York River Basin Study Committee (1950).
8. Missouri Basin Study Commission (1952).
9. Commission on Intergovernmental Relations (1953) (Kestnbaum Commission).
10. Commission on Organization of the Executive Branch of the Government (Second Hoover Commission) (1953).
11. Presidential Advisory Committee on Water Resources Policy (1954).
12. Texas Study Commission (1958).
13. Southeast Study Commission (1958).
14. Senate Select Committee on Natural Water Resources (1959).

2. Public Health

Public health programs related to water resource development[1] were primarily matters of State and local concern up to about 1900. Local efforts--the construction of sewer systems, water supplies and water treatment facilities--accounted for the major part of this action. State efforts, while recognizing environmental hazards as contaminated water supplies, were neither adequately organized or staffed to provide leadership in any substantial amount. This is not to underestimate the importance of the organization of State boards of health. However, State efforts at that time were only beginning and are not to be compared with the well-structured and staffed State health departments that come into general use by 1920.

By the turn of the century, new scientific knowledge, urbanization and greater public awareness that the diseases were not a necessary evil stimulated enlargement and expansion of the national health organization--the U. S. Public Health Service. Because of the leadership role provided by this Federal health establishment and the close association of the Federal and State health agencies during the first half of the Twentieth Century, a review of the water resource development programs of the Public Health Service also provides close insights into the development of State health agencies and their sanitary engineering divisions as well.

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[1] The words, "water resources" used in connection with public health in this chapter relate to functions involving domestic, municipal and related water supplies; sewage and industrial waste treatment facilities; pollution control and other water quality management activities; the control of disease-carrying insects, as mosquitoes, associated with water resource development projects; and multi-purpose river basin development programs involving or including these functions.

The background of the Public Health Service's water resources program has been divided into five time periods. From about 1870, the time of the transmission from Europe to America of the new scientific knowledge in the field of bacteriology up through the First World War, there were major developments in the initiation of fundamental surveys which underly much of today's current public health engineering practices. During this period, there was developed much of the basic legislation for the Public Health Service's activities up to 1948. The first standards were developed during this time and, in numerous other ways, the foundations were laid for the work to be accomplished during the first half of the Twentieth Century.

The years from the end of World War I to the Depression in 1932 were very productive in terms of program development between Public Health Service and State agencies. The Conference of State Sanitary Engineers, organized in 1919, greatly stimulated cooperative action between the States and the Federal government and saw the development of the bases for most of the current-day operational programs in the entire field of environmental health. If some were not fully carried through to actual operation, they were at least visualized and recognized as problems.

The third time period, from 1933 to 1940, saw a continuous expansion of the Federal government's role in the operational health programs of the Nation. Service personnel exerted significant leadership in many fields that affected environmental health work. Public works programs were inaugurated as an instrument of newly recognized Federal responsibility for the economic condition of the citizens of the Nation. The social security idea blossomed into actual legislation, with its attendant impact on public health.

The years 1941-1952 brought tremendous industrial growth, massive forward surges in the sciences of chemistry, biochemistry, radiation, enormous consumption of raw materials and resources, accumulation of huge backlogs of needed civil works. During this period, Public Health Service laws were codified into the current Public Health Service Act, and the National Water Pollution Control Act was passed.

From 1952 through 1961, new and major developments took place in the problems affecting the environment and particularly in the water resources programs of water supply and water quality management and the impact of these two functions in broad multi-purpose river basin development programs.

A. 1901-1918.

The foundation for the Public Health Service policy of cooperation with and assistance to the States was laid in the early 1870's. At that time, a scant half-dozen State health departments existed--the first was established in Massachusetts in 1869. Although information regarding the relation of environment to health, which had been available since the mid-century in the reports of Shattuck and Snow, (26, 47) provided guides to activity in this field, few if any of the States had the professional staff and organization to carry on programs related to the control of the environment. This condition prevailed generally well into the first decade of the new century. Indeed, even as late as 1915, only thirty of the State health departments had sanitary engineering personnel, and half of those had only one person working in this field. (See Table 8)

It was general practice, therefore, at the request of State or local authorities, to assign medical officers of the Marine Hospital Service to assist local communities in combating the frequent epidemics of typhoid, yellow fever, cholera, and smallpox occurring during that period. (48) Following Dr. Kinyoun's European studies relating to cholera and other contagious diseases, the Service undertook to develop further information and programs that would protect this country from epidemics.

Interstate Quarantine Regulations. The first of the major actions which brought the force of the Federal government into play, through the Marine Hospital and Public Health Service, were the National Quarantine Act of 1878 (to prevent introduction of contagious disease into the United States), the Act of 1890 (to prevent interstate spread of infectious disease), and the Act of 1893 (establishing a legal authority for interstate quarantine regulations).

The history is clear that the Interstate Quarantine Regulations were developed primarily to combat the yellow fever epidemics prevalent in this country during the 19th Century. However, the mechanics set up through these regulations were applicable to other areas of disease control as well. As early as 1908, following investigations which traced some occurrences of typhoid to contaminated water on vessels and trains, suggestions were made that interstate quarantine regulations be issued to assure safe water supplies on interstate carriers. Such regulations were promulgated in 1913. (49, p. 21) (50, p. 49) (51, p. 192) An interesting note on the manner of the execution of the Interstate Quarantine Regulations was the order of the Surgeon General (Circular 49, October 5, 1912) requiring that officers in travel status make observations of the conditions of interstate carriers and report those observations to the Surgeon General. These reports provided much of the background on the epidemics occurring because of consumption of impure water on vessels and trains at that time. (52, p. 253-55)

For the purpose of administration of the Interstate Quarantine Regulations, the United States was divided into twelve sanitary districts. Laboratories were established at central cities in these divisions, and officers were assigned to conduct from those localities investigations of matters relating to the interstate spread of disease. (53, p. 271)

Two amendments to the Interstate Quarantine Regulations, adopted February 12, 1917, are of particular interest. One provided for a sanitary survey of the watershed from which drinking water supplies are obtained, in addition to the previously required bacteriological analysis. The other gave authority for inspection of places where shellfish were grown, fattened, or handled, and prohibited interstate transportation of those found to be liable to become agents in the transmission of disease. (54, pp. 232, 234-5)

Drinking Water Standards. Official drinking water standards were first adopted in 1914 as an aid to administering the Interstate Quarantine Regulations. Their adoption stemmed from the need to have acommon base for the determination of the sanitary condition of water supplies, and a foundation for the actions being taken to prohibit use of certain water supplies by common carriers. They were recommended by a Commission on Water Standards, appointed on January 22, 1913, by the Secretary of the Treasury. The Chairman of the Commission was the director of the Hygienic Laboratory, and other membership included fourteen public health and engineering specialists from universities, State health departments, and technical organizations. (53,p.269)

Considerable care was exercised in determining the standards, more than a year being devoted to discussion and study of the problems involved. As recommended by the Commission and adopted by the Department of the Treasury on October 14, 1914, the standards provided certain maximum limits of permissable bacteriological impurity. It was emphasized that they did not represent the nearest approximation to purity which it is desirable to attain in drinking waters, but rather the furthest deviation from purity considered permissable and safe. They were in no sense a standard for municipalities, nor did they indicate the ideal potable water. They were based solely on the results of laboratory examinations and did not include sanitary surveys of watersheds and the enumeration of undesirable or dangerous conditions thereon (a procedure which, it was noted, would be of great value). The matters of physical properties, mineral constituents, and chemical impurities were not dealt with in the adopted standards, but were left for future consideration. (52, p. 89) (53, pp. 369-71)

Between 1914 and 1917 there was continued activity in the control of common carrier water supplies along the same general lines as first initiated. Throughout this period, continued cooperation was maintained with State and local health authorities in the processes of supervising and controlling the water supplies served to common carriers. Suggested amendments to the Interstate Quarantine Regulations were considered at the 1915 Conference of State and Territorial Health Officers. (An annual conference between these officers and the Surgeon General had been initiated in 1902, in accordance with the direction in the 1902 Public Health Service Act, as a means of furthering cooperation with the States.) At this 1915 Conference, the Chairman stated: "As you know, the Federal law provides that the government shall cooperate with the States, and that the regulations to be enacted by the Secretary of the Treasury shall operate uniformly. There is nothing in this or any other Federal law to prevent the States from enacting such further regulations as they may deem necessary. I think it is the intention of the Bureau that amendments to these regulations shall be made an order of business of this conference hereafter from year to year." (55, p. 15)

Water Pollution Studies. In 1901, construction of the Public Health Service Hygienic Laboratory was authorized, "for the investigation of infectious and contagious diseases." This new laboratory, completed and occupied in 1905, replaced the inadequate facilities first established by Dr. Kinyoun in the Staten Island Marine Hospital in 1887, and moved to Washington in 1891. (48, p. 177) In 1901, too, a division of scientific research was organized. Typhoid caused by polluted drinking water was widespread at that time, and it was natural that attention should be directed immediately to the importance of studying stream pollution in relation to disease. (56, p. 302)

Several investigations of typhoid outbreaks at scattered points during the century's first decade included consideration of polluted water supplies as a possible cause.[1]

In 1908, at the recommendation of the Mayor of Chicago, an interstate commission to study and report on pollution in Lake Michigan was formed. The cooperation of the Public Health Service was requested. Membership of the Commission included representatives of the War Department, the Public Health Service, the cities of Chicago, Milwaukee, and Grand Rapids, and the States of Wisconsin, Illinois, Michigan, and Indiana. (50, p. 49) Later that year a similar group, composed of representatives of cities on the borders of Lake Erie, was organized to collect data, "and excite interest regarding the necessity of protecting water supplies." (57, p. 45) The findings of both of these groups pointed to the need for legislation to prevent pollution of interstate waters. Such legislation was introduced in the Congress, but was not enacted. (57, p. 46, 233-6)

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[1] These were comprised of investigations at Lexington, Virginia (reported in Public Health Service Annual Report 1904, pp. 27, 381), District of Columbia (reported in Public Health Service Annual Report 1906, pp. 221-2 and Public Health Bulletin No. 35), Savannah, Georgia, and Charlotte, North Carolina (reported in Public Health Service Annual Report 1907, pp. 12, 29 and Public Health Reports, August 17, 1906), Forest Glen, Maryland (reported in Public Health Service Annual Report 1909, pp. 43-44), and Omaha, Nebraska (reported in Public Health Service Annual Report 1910, p. 19 and Public Health Bulletin No. 70).

In 1910, the first systematic investigation of the status and effects of sewage pollution in any large area was begun in the Great Lakes region. This included study of the extent of pollution of the water supplies of cities in the area, and its relation to the prevalence of typhoid fever and other waterborne diseases, and an examination of State and municipal ordinances relating to its control. (56, p. 302) (58, p. 35) In 1912, a survey of the sewage pollution of the Missouri River, including a rather extensive series of bacteriological examinations, was made. The State of Kansas requested the Public Health Service to make this survey, in view of its interstate nature. It was carried out in cooperation with the States concerned. (51, p. 41) (59) p. 22)

In 1912, Congress extended the function of the Public Health Service to include that of investigating, "the diseases of man and conditions influencing the propagation and spread thereof, including sanitation and sewage and the pollution, either directly or indirectly, of the navigable streams and lakes of the United States." In 1913, an appropriation was made which enabled the Public Health Service to establish field laboratories and to employ scientific personnel especially qualified to conduct investigations in various fields of research. A group of sanitary engineers, chemists, biologists and bacteriologists was assembled and a beginning was made on a concerted plan for investigations relative to stream pollution. The work included (a) studies of the biochemistry of sewage and industrial wastes--particularly testing and developing the application of Biochemical Oxygen Demand determinations to the measurement of the potential polluting effect of sewage and the capacity of streams for its oxidation; (b) studies to devise better methods for the treatment of various important industrial wastes for which economical and effective processes had not previously been evolved (including strawboard, creamery and tannery wastes); (53, p. 110) (60, p. 77) (c) a study of the pollution and natural purification of the Potomac River--effect of sewage from Washington on waters near the mouth of the river where important shellfish beds are situated. (This study was later extended to include various other coastal waters with special reference to contamination of shellfish.) (52, p. 105) (51, p. 42) (d) a study of pollution and natural purification of the Ohio River. (52, p. 98) (53, p. 99)

All these studies were under the direction of the Division of Scientific Research in Public Health Service and were pursued as interdependent parts of a common plan. Subsequent to the Great Lakes Studies, the Service cooperated with the International Joint Commission in investigations to determine nature and extent of pollution of waters between the United States and Canada, with a view to suggesting measures of control. (51, p. 42)

Shellfish Investigations. An outbreak of typhoid in the District of Columbia during the winter of 1908-9 was attributed in large part to contaminated oysters. During the summer of 1914, the Service investigated oyster-growing beds at Biloxi and Gulfport, Mississippi, and recommended elimination of sewage polluted areas. (61) The first widespread field investigations of the sanitary quality of shellfish-growing areas in the United States began in the lower Potomac in 1913-14. The studies were extended then to all other shellfish producing areas in the tidal waters of Maryland and Virginia. (52, p. 107) (53, p. 108)

In 1915-16, similar studies were made of certain tidal waters of New Jersey, Delaware and New York. (62) Experiments in the artificial purification of polluted oysters were also conducted at this time.

With the incidence of the national emergency in 1917, the major resources of the Service were employed in support of the military and defense program.

Investigations concerned with research in purification of water supplies and stream pollution were put aside in favor of malaria control operations, extra-cantonment sanitation, and similar activities.

Malaria Control. Extensive studies carried out by the Service between 1914 and 1917 had provided the fundamental facts concerning malaria transmission and control in the United States--economic losses caused by malaria; feasibility of the different methods of control; importance of American anophelines in malaria transmission; and the relationship of impounded waters to malaria. (63) Resulting from the impoundment studies, which revealed that malaria-transmitting mosquitoes were numerous near impounded waters, came the suggestions that trees, brush and floatable materials be removed from proposed basins to reduce breeding places, and that there be seasonal control of water levels. While the studies were not considered complete, they did provide basic facts for formulation of State and Federal regulations on impoundment projects.

These studies and reports of the Hygienic Laboratory during the first years of its existence and the later Environmental Health Center studies between 1901-18 began to clarify and bring into position the relationship between the Federal government and the States, and to provide a correlation of current scientific knowledge available with regard to the control of diseases on the incidence of which water has a direct or indirect bearing.

B. 1919-1932.

Post-war Program. After the war, the Service formulated a comprehensive program to meet the pressing health needs then apparent. Since past experience had proved that success in public health activities could best be achieved through cooperation of Federal, State, and local health authorities and voluntary organizations, the program was developed on this basis. Several segments of the proposed program bore a direct relationship to water resources:

2. Rural hygiene:

   (a) Federal aid extension for establishment and maintenance of adequate county health organizations....

   (b) Detail of specially trained officers of the PHS to formulate and carry out, in cooperation with local authorities, intensive campaigns for the sanitation of groups of rural towns, the work to be directed especially toward securing safe water supplies, cleanly disposal of human excreta....

   (c) Studies by a special board of Service officers to determine improved methods of rural sanitation....

   (d) Widespread dissemination of the simple rules for rural sanitation through various Government and civil agencies, such as the bureaus and divisions of the Department of Agriculture, the Farm Loan Board, agricultural colleges, public school boards, farmers' associations, and women's clubs.

4. Water supplies--National development of safe water supplies:

   (a) By extending surveys already made by the PHS of water supplies, checked by laboratory analyses when necessary, to be done by national, State, local, or university personnel and laboratories.

   (b) Introduction and extension of methods of water purification according to results of surveys and analyses.

   (c) Stimulation of communities to obtain safe water through national, State and local representatives and volunteer organizations.

5. Sewage Disposal--Proper sewage disposal will control intestinal diseases, such as typhoid fever, dysentery, diarrhea, and hookworm. These diseases now cause over 60,000 deaths annually. National development of safe methods through--

   (a) Extension of water carriage systems wherever practicable.

   (b) Elimination within municipal limits of cesspools and privies.

   (c) In rural communities the installation of sanitary privies.

   (d) The establishment of minimum standards of permissable pollution of streams, lakes, and rivers used for water supplies.

(e) Stimulation of communities through national, State, and local representatives and volunteer organizations, to obtain safe sewerage disposal.

7. Malaria--National development of measures for the control of malaria and malaria-bearing mosquitoes in industrially, agriculturally, and economically important areas of the United States--

    (a) By the further dissemination of the knowledge of methods for its control (elimination of malaria-mosquito breeding places through drainage, oiling, ditching, and the like) now being demonstrated by PHS.

    (b) By the extension throughout the country of surveys of certain areas as to the prevention of malaria and malaria-bearing mosquitoes.

    (c) By increasing the corps of experts of the PHS engaged in malaria prevention and by the utilization of other national agencies wherever practicable to advise the communities as to the methods for best handling their problems in malaria.

    (d) Additional appropriations for the reclamation of large areas from malaria through proper drainage...especially applicable to the control of malaria in communities where malaria conditions interfere with their economic development.

10. Railway sanitation:

    (c) Protection of the public by--

        (1) Sanitary supervision of water...supplies furnished by railway administration.

        (3) Sanitation of station, terminals, rights of way, with special reference to sewage disposal, malaria-mosquitoe eradication....

11. Municipal sanitation:

    (c) Provisions for safe water supplies and sewage disposal.

    (g) Control of malaria and malaria-bearing mosquitoes in malarious regions.

12. Health standards:

    (c) Sewage and excreta disposal. Minimum standards should be promulgated on the following: (1) Water-carriage sewerage systems; (2) sanitary privies.

    (d) Standard specifications for safe water and water purification. (64, pp. 17-20)

Conference of State Sanitary Engineers. A development destined to have far-reaching influence in the field of State public health work took place in the year following the end of World War I. In December, 1919, a group of State sanitary engineers attending the American Public Health Association meetings in New Orleans discussed the need for closer cooperation among the States in their particular field of activity. Those present formed a temporary organization, and on May 25, 1920, an official organization meeting to which all State sanitary engineers were invited was held. In outlining the purpose of the proposed organization, at that meeting, Mr. V. M. Ehlers, then Chief Sanitary Engineer at the Texas State Board of Health, said:

> In these days of progress and accomplishment, cooperation and unity of purpose have been deciding factors to success. Captains of industry as well as the knights of labor recognize in cooperation and union the signposts that direct the way to the goal of attainment....
>
> The field of proposed cooperation covers the entire sphere of activity of the State sanitary engineer. While it is true that some of the problems confronting us down in the South are not as pertinent in the Northern States, the fact remains, nevertheless, that mutual good could be accomplished by comparison of methods practiced and results obtained. Nearly all really important propositions have a close sectional co-relationship.

Among the problems listed by Mr. Ehlers as being most vexing to the State engineers of that time and the solution of which was most urgently needed, were treatment and disposition of domestic and industrial wastes; need for definition of what constitutes stream pollution (especially important when interstate); lack of uniform standards and uniform State laws; protection of water supplies, sanitation of swimming pools; the housing problem; mosquito control, etc. That list was prepared in 1920--it could, with a few deletions and additions serve as a list of current problems in the field of sanitary engineering.

In proposing that the PHS provide a secretary for the Conference, whose office would serve as a clearing house for reports and perform other coordinating functions, Mr. Ehlers stated:

> The USPHS, as we all know, has been of great value to us in lending us material aid and assistance in furthering our work in the several States. Our aims and ambitions are very closely related.... It is our opinion that if a scheme of procedure similar to the one outlined is adopted and put into effect, not only will the science of sanitary engineering be greatly benefited but valuable service will be rendered the citizens of this country. (65, pp. 2-4)

The Conference of State Sanitary Engineers contributed a great deal to making the 1919-1932 period one of the most productive in the history of the environmental health service activities, especially from the point of view of the development of common objectives between the States and the Federal government, of common standards, technical procedures, and acceptance of certain scientific bases, limited though they were, as the foundation for actual programs to be carried out in the States. The Conference provided a meeting ground for the testing of new ideas, for the diffusion of ideas to others on an informal, give-and-take basis, in an environment in which discussions could be had and points of view explained. This resulted, over a period of time, in voluntary acceptance on the part of the members of the Conference of a great many common views. In retrospect, it appears that little, if any, greater progress could have been achieved by any formal arrangement of law or otherwise which would have forced the States to adopt policies at any one particular time. The Conference procedure, given the time element and the stage upon which ideas could be presented in a free atmosphere, in its small way typified the American democratic process.

A brief review of some of the matters taken up by the Conference and its committees during the first years of its existence will indicate the ultimate value to be derived from the presentations, discussions and development of generally agreed upon opinions on common questions.

At the time of the first Conference, in 1920, most of the States were seriously concerned with the matter of water supply sanitation. The general situation in this regard was well expressed in the paper on "Coordination of the Control of Drinking Water on Interstate Carriers with Engineering Functions of State Departments of Health", presented by C. M. Baker, then State Sanitary Engineer, Wisconsin State Board of Health. In discussing the 1914 Drinking Water Standards, Mr. Baker stated:

> It should be borne in mind that these early regulations were put into force at a time when few if any of the States had adequate facilities for proper control of their water supplies by sanitary surveys, and that in many cases even suitable laboratories were not available. In fact, a survey of the facilities of the various States for the control of water supplies by the USPHS early in 1919 showed that less than one-half of the States were well equipped for this work, 12 of the remainder had no sanitary engineers, but were equipped with meager laboratory facilities, while one State had neither an engineer nor laboratory. It is obvious, therefore, that although some States are well qualified to control their own public water supplies, and in connection therewith those of all common carriers, general control by the USPHS is still essential. The purity, not only of public water supplies, but also of those of common carriers within the State, should, however, be of prime interest to the State itself, because of the great danger to the inhabitants thereof when these supplies are impure.... (Emphasis supplied)
>
> It is believed that the control of the water supplies of common carriers as well as of all public supplies should be mainly if not wholly under the supervision of the respective State departments of health, providing these departments are adequately equipped for such control. (Emphasis supplied)

In his summary, Mr. Baker re-emphasized:

> In those States where such facilities are not available, the USPHS should retain control and, in cooperation with State officials, should endeavor to build up the necessary organization. In this connection, the Service should be in a position to furnish engineering and laboratory personnel to assist these States. In connection with this work, assistance could be given not only in the control of water supplies of common carrier, but also in building up effective State organizations for the control of sanitary conditions generally within the State. (Emphasis supplied) (65, p. 28)

It may be noted that one of the objectives the Service was looking forward to at this time was a strengthening of State organizations. The mechanism set up for interstate quarantine practice had been conceived as one means by which the development of State agencies might be stimulated. Ten Service officers were detailed to the States in 1919 to assist in the prevention of the interstate spread of disease. Requests were received from more than thirty States, but the number provided was limited to ten because of scarcity of personnel available. (64, pp. 79-80)

The interchange of technical documents through the Secretary of the Conference was initiated in 1921 as proposed at the first meeting. These were issued as Public Health Abstracts and their publication has been continued to the present day. Also in 1921, questionnaires were distributed by the Water Supply Committee and the Committee on Stream Pollution for the gathering of data on the National situation in these fields. An initial statement of policy with regard to cross-connections was submitted to the 1921 meeting by the Conference Committee on Cross-Connections, Bypasses, and Emergency Intakes on Public Water Supplies.

At the 1922 meeting Mr. H. A. Whittaker, of the Committee on Laws, Organization, Policy and Procedure, reported that the Committee's survey of State organization for handling sanitary engineering problems indicated lack of uniformity in almost every phase of organization (name, authority, personnel, funds, facilities, duties) probably due to the variety of conditions under which the organizations came into being. (66, pp. 3-7)

The Committee on the Limitation and Control of Chlorination of Water presented its first technical report at this meeting, commenting on the efficiency of chlorination practice. (66, pp. 19-26)

In 1923, problems concerned with the collection and shipment of water samples were discussed by C. A. Holmquist (New York). (67, pp. 30-46) There were discussions on the policy of establishing small water works laboratories. (67, pp. 49-51)

In 1924, there was a status report on engineering activities in State Health Departments. There were also discussions of bathing places, bottled waters, sewage disposal, stream pollution policies, and industrial waste effects on stream pollution. (68)

In 1925, the Committee on Sewage Disposal and Stream Pollution gave consideration to uniform laws. A report was presented on the Chicago typhoid outbreak caused by polluted shellfish. A Joint Committee on Bathing Places was established with APHA, and joint committee work was initiated with AWWA on watershed control. (69)

In 1926, there was reference to the development of comprehensive programs by the Committee on Sewage Disposal and Stream Pollution, with special consideration given to interstate streams. At the 1926 meeting the adoption of coliform standards for bathing places was also considered and the initiation of a water treatment plant census by C. G. Gillespie was reported. (70) This census was later extended to the field of Sewage Works.

In 1927, there were discussions on the recreational use of water supply reservoirs. (71) Committees active throughout this period included those on Milk Supply, Water Purification and Treatment, Sewage Disposal and Stream Pollution, Bathing Places, Shellfish, Development of Ground Water Supplies, Camp and Outdoor Sanitation, and Cross-Connections.

1925 Drinking Water Standards. In 1922, the Surgeon General appointed an Advisory Committee on Official Water Standards to review the 1914 Standards for Drinking Water for Interstate Carriers and to recommend a standard or standards, based on specific methods of laboratory analysis and field survey, and applicable to all classes of water supplies coming within the supervision of the Interstate Quarantine Regulations. This action was deemed necessary for several reasons. The wide divergence of practice existing among

State health departments in making bacteriological and chemical examinations of water, in making sanitary surveys of water supplies, and in judging the sanitary quality and safety of water, had caused difficulty in administration of the IQR's relating to drinking water. In addition, contrary to the intent of the Commission which recommended the 1914 Standards (see discussion on page 6), these standards were being applied in many instances to municipal water treatment plants and were being used in courts as the legal standard for the purity of water. A review of the current standards and a specific definition of their limitations and applications seemed called for.

In submitting its recommendations, the Committee defined its task as being, "to formulate definite specifications which may be used by the Public Health Service in the administrative action which it is required to take upon the supplies of drinking water offered by common carriers for the use of passengers carried in interstate traffic. The recommendations submitted apply, therefore, only to this special case, and are not proposed for more general application."

The recommended standards set up certain objective requirements to conform to a general standard of safety comparable to that of the better class of municipal water supplies. The standard recommended including certain requirements relative to the source and protection of the water supplies in question, as indicated by a careful sanitary survey, and certain other requirements relative to bacterial content as shown by standard tests. The requirements as to source and protection were based on well-recognized principles of sanitary engineering and were stated in general terms implying broad consideration and the exercise of discretion in judging ultimate fitness. The bacteriological standard was stated in definite quantitative terms, but the committee recommended that in practice it be applied with some latitude, permitting acceptance of supplies found satisfactory in other respects, after rigid inspection, at the discretion of the certifying authority.

Water Pollution Studies. During the 1919-1932 period, there was continued energetic activity by the Cincinnati group in the further development of basic knowledge on the pollution of streams. At the same time, Streeter was making his fundamental surveys of 31 water supplies in the Ohio River and Great Lakes area, upon which to this very day we have depended for our views with regard to the ability of water purification plants to remove bacterial pollution. These surveys included observational studies of the bacterial efficiency of municipal water-purification plants, which were made in connection with a comprehensive study of the relations existing between the pollution of raw water supplies, taken for purification from streams receiving sewage and other wastes, and the sanitary quality of effluents produced from such sources of supply by current processes of water purification. (72)

Experimental studies of water purification methods were made over a period of about six years, beginning in August, 1924, at the Stream Pollution Investigation Station in Cincinnati, utilizing a large-scale experimental filtration plant of the rapid sand type, constructed on the grounds of the Station.

Some of the first studies of the pollution of ground waters were made during this period at Fort Caswell, North Carolina, by C. W. Stiles, H. R. Crohurst, and Gordon E. Thompson. (73)

Shellfish Investigations. During the Winter of 1924-25, a series of typhoid outbreaks in New York, Chicago, and Washington were traced to raw oysters from New York. After a thorough investigation by the Public Health Service, the Surgeon General called a conference (February, 1925) at which State and local health authorities and the shellfish producers requested the Service to undertake supervision over the sanitary quality of shellfish shipped in interstate commerce. Complying with this request, the Service, in cooperation with others concerned, developed a system of endorsement of State control measures, whereby each State presented a list of certified dealers conforming to State requirements. Such lists were published for the information of consumer States. To establish the degree of State control deemed essential, the Public Health Service prepared the "Minimum Requirements for Endorsement of State Shellfish Control Measures and Certifications for Shippers in Interstate Commerce".

C. 1933-1940.

Broad national programs of public works, social security, and national resources planning, which were initiated during this period in an effort to cushion or eliminate future depression cycles, gave major impetus to public health activities in a variety of areas.

Social Security Act. Section VI of the social security legislation enacted in 1935 was designed to stimulate a comprehensive, nation-wide program of public health, financially and technically aided by the Federal government, but administered and supported so far as possible by the States and local communities. It gave to the Public Health Service legal authority to act as partner, adviser, and practical assistant to State health departments, and through them to municipal and local health services. The Federal funds made available under the Act were utilized to strengthen the State and

Territorial health departments and provide adequate facilities, through State agencies to strengthen and aid in development of district, county and city health services; to train personnel in State and local health departments. State and Territorial health authorities cooperated with the PHS in development of the regulations promulgated for the administration of these grant-in-aid funds. (48, p. 154)

Grants-in-aid to States for public health work did not become available until February, 1936, yet by the end of that fiscal year thirty-three and, by 1939, practically all States had expanded their sanitary engineering forces. According to reports of the Conference of State Sanitary Engineers, the number of assistant engineers and other technical personnel attached to State health departments increased between 1931 and 1939 by 90 percent and between 1931 and 1944 by 169 percent. By enabling increases in personnel, grant-in-aid money gave great impetus to decentralization and wider coverage of State health department services. State sanitary engineers were assigned to newly established State district offices, and additional local health departments were made possible, especially in rural areas. (74, p. 21)

WPA-PWA. Early in this period, Federal funds became available for construction projects sponsored by the Works Progress Administration in cooperation with the Public Health Service and State and local health departments to supplement local programs in rural sanitation. These projects consisted chiefly of building sanitary privies in rural and suburban areas where sewer systems were not considered economically practicable. Between June 30, 1935, and June 30, 1940, nearly two million sanitary privies were built and numerous repairs made.

WPA funds were also utilized in programs designed to abate stream pollution caused by seepage from abandoned pits in mining districts. By the end of 1940, employees of WPA, in cooperation with State sanitary engineers, had sealed 4,083 mine units, thus reducing the sulphuric acid content in water supplies by about 627,000 tons per year.

Between 1935 and 1941, States assisted by WPA cooperated on malaria control projects resulting in construction of 15,600 miles of ditches and draining 286,000 acres of land which had served as breeding places for a. mosquitoes. (74, p. 22)

From its inception, the Public Works Administration recognized the importance and need of sewerage works and designated their construction as desirable. From 1933 to 1939, Public Works allotments were made for 1,527 sewage systems costing more than $466 million, representing 11 percent of the estimated cost of all PWA non-Federal work. Sewage treatment works alone accounted for 873 projects costing $325,358,000. About 67 percent of all new sewage treatment plants constructed between 1933 and 1939 were PWA projects.

As PWA studied the Nation's sewerage problems, it adopted a policy of refusing to be a party to the construction of any sewerage system which permitted untreated wastes to enter into any lake or stream so as to increase pollution. As a result, the construction of many disposal plants was hastened. (75)

In making allotments, PWA followed a policy of giving preference to projects which conformed to local and regional planning, and of assisting in such planning. For example, through making allotments for sewerage works and sewage treatment plants to several communities utilizing the same stream for the disposal of wastes, it aided in the cleaning up of polluted watersheds. (76, p. 116)

In the field of water supply, PWA made allotments for 2,419 non-Federal waterworks projects costing $311,845,653, actual construction varying from 37 to 77 percent of all new non-Federal waterworks construction a year. More than 500 water treatment plants of various types were constructed.

In 1919-20, municipalities spent an average of $119 million a year for new waterworks construction. By 1933, the amount dropped to less than $47 million. Between 1933 to 1939, new construction rose to an average of approximately $85 million a year. PWA financed projects accounted for about fifty percent of this total. (75)

Early in the depression period, the Conference of State Sanitary Engineers had recognized the desirability of encouraging construction of needed sanitation projects as one measure of stimulating employment. At its 1931 meeting, the Conference appointed a Committee on Sanitation Projects for Unemployment Relief. That committee met immediately and reported back at the same meeting, the keynote of its report being that a reasonable share of public and private funds available for unemployment relief could advantageously be used for the improvement of environment for the protection of public health, referring specifically to water supplies, sewerage, refuse, garbage, malaria control, rural sanitation and reclamation of wet lands.

At the 1933 meeting, one entire session was devoted to a discussion of public works projects under the National Recovery Act. Difficulties being encountered by the States in connection with applications for local projects were reported, and a resolution was adopted urging, in view of the many problems impeding the rapid preparation of plans for sanitary public works within the time limit set, that the PWA protect the allocation of funds needed for those projects until they might be adequately developed. (77, pp.15,31)

Water Pollution Studies. Investigations pertaining to the uses of water, its pollution and purification were continued by the Service's Environmental Health Center during the 1930's. The projects pursued included observation of biochemical oxidation of organic matter, as it functions in biological methods of sewage treatment; experimental work on determination of rates of oxygen withdrawal from flowing water by underlying sludge deposits; study of the sanitary condition of the Scioto River as affected by installation of modern methods of treatment of contributed sewage; initiation of a nation-wide continuing census of water and sewage treatment plants; an extensive laboratory study of the sanitary condition of the Ohio River and its tributaries; sewage treatment studies having the primary objective of determining the factors that impair efficiency of the activated sludge methods of sewage purification; experimental studies designed to develop practical methods of evaluation of capacities of flowing streams for natural oxidation of sewage and other organic wastes.

Water Pollution Control Legislation. Support for comprehensive Federal water pollution control legislation began to crystallize during this period. Although nearly every Congress since the turn of the century had had one or more bills on the subject before it for consideration, almost one hundred bills having been introduced in that period, the Barkley-Vinson bill presented in 1936 was the first having the comprehensive features which characterize the present Act.

Both the Senate and the House passed this bill, but in the closing hours of the session a member who had been absent when it passed the Senate asked for reconsideration and the bill died.

In 1938, a revised bill was again approvedby both Houses, but was vetoed by the President because of technical defects relative to allocation of grants. In 1940, a third revision, considerably changed, was adopted by the Senate, and was also passed by the House but with an amendment in which the Senate refused to concur. There, this bill, too, died.

Pollution abatement was receiving increased attention in the States, also, during this period. By 1938, water pollution control was considered a function of 37 State health agencies. At that time, fifteen States had laws which permitted a "maximum or optimum" degree of control; by 1946, 21 States had such legislation. Provisions and effectiveness of these laws differed greatly, but suggested increasing public interest.

D. 1941-52.

Emergency Health and Sanitation Program. During World War II, as the Federal agency most directly charged with helping to safeguard the Nation's health, the Public Health Service was faced with responsibility of assisting States and local communities to maintain normal health standards in spite of the abnormal demands upon their health facilities created unprecedented population shifts, tremendous industrial expansion, and lack of trained personnel.

In February, 1941, an Advisory Committee on Revision of the 1925 Drinking Water Standards was appointed by the Surgeon General, at the suggestion of the American Public Health Association, American Water Works Association, and American Chemical Society that the standards be reviewed. The Committee was composed of representatives of Federal agencies, scientific associations, and three members at large. The principal revisions made to the 1925 Standards included (1) separation of the text into two sections--(a) statement of standards, and (b) recommended manual of water works practice; (2) option given for use of either 10 ml or 100 ml as standard sample for bacteriological test; (3) concentration limits set for certain chemicals; and (4) provisions included to detect contamination from faulty plumbing, cross connections, etc. (79)

1946 Drinking Water Standards. In 1946, slightly revised standards were adopted on recommendation of the same Advisory Committee. The revisions were principally for claification of wording, in order that the Standards would be uniformly applied. Whereas the previous standards had been designed to apply specifically to water supplies used by interstate carriers, the 1946 standards were written in such a manner to permit application to all public water supplies if the States so desired. In 1946, the Manual of Recommended Water Sanitation Practice was printed as a separate document, (80) rather than being included under the same cover with the Standards. This was felt desirable, since it had been found that although intended merely as an advisory guide, the manual was being used in some instances as part of the Standards.

The officers and directors of American Water Works Association, on January 14, 1946, adopted a resolution voluntarily accepting for the Association, the 1946 revision as standards for all public water supplies.

In its Manual of Water Quality and Treatment, the American Water Works Association recognizes that, "However meritorious the purpose or performance of any water works man, it is important to provide him with a yardstick by which he can measure his achievement. Standards of quality can do not only that, but, properly enforced, can guarantee at least a minimum level of achievement. Moreover, the progress of the water works field as a whole can best be measured by the progressive improvement of its standard of quality." (81, p. 68)

Sanitation Manual for Public Ground Water Supplies. In 1944, a Sanitation Manual for Public Ground Water Supplies was issued for the guidance of States, municipalities, and health districts, in order to encourage a greater uniformity and a higher level of safety in the sanitary control of public ground water supplies. Work on this manual had been under way since 1937, when the Public Health Service appointed a Water Sanitation Advisory Board to consider the formulation of a water supply section as part of a general sanitation code. The manual was prepared with the thought of indicating desirable practice or minimum acceptable standards, for optional use by the States in adopting regulations.

National Inventory of Sanitation Needs. In 1943, the preparation of a national inventory of needs for sanitation facilities based on Census data was begun. Among these were needs for Public Water Supply, Sewerage and Water Pollution Abatement, and were published during 1944. The inventory disclosed that the estimated cost for provision of the needed facilities totaled approximately three and one-half billion dollars, of which public water supply accounted for $803,300,000; sewerage and water pollution abatement, $2,255,150,000, of which $656,190,000 (29 percent) represents the cost of new sewer systems, $559,160,000 (25 percent) the cost of intercepting sewers incidental to the addition of treatment works to existing sewer systems, and the remaining $1,039,800,000 (46 percent) the cost of sewage and industrial waste treatment. (82, p. 10)

In 1950, under the provisions of the Water Pollution Control Act of 1948, the inventory of sewage and industrial waste treatment plant needs was brought up to date through a cooperative Federal-State program involving collection of all available pollution data on the 226 river basins of the country. On the basis of the needs disclosed at that time, it was estimated that the total cost of a national municipal and industrial pollution abatement program would range roughtly from $9 billion to $12 billion, depending on the water uses finally chosen. (83, p. 37)

Public Health Service Legislation. The Public Health Service Act of 1944 (PL 410, 78th Congress) brought together for the first time since the organization of the Service, all existing public health legislation. In addition, it provided for greater assistance to States in establishing and maintaining adequate public health services, and the development of coordinated research into causes and prevention of all diseases.

Water Pollution Control Act. On June 30, 1948, the Federal Water Pollution Control Act was signed into law by the President (PL 845, 80th Congress). This action culminated more than fifty years of effort by individuals and groups representing a wide variety of interests, but all having the common goal of protecting the Nation's water resources. Several similar bills were introduced during the 80th Congress (S. 418, H. R. 123, H. R. 315, and H. R. 470). The one finally adopted, after extensive hearings before both Senate and House Committees on Public Works, was S. 418, sponsored jointly by Senators Taft and Barkley.

Research. During the war years, research activities were in large part limited to special defense-connected surveys and investigations. After the war, fundamental research in water and sewage was resumed.

The areas of work covered include the development and evaluation of analytical techniques for both organic and inorganic materials; studies of persistence of particular organic compounds in water; application of biological oxidation processes to waste purification; studies of industrial waste sources, characteristics, and corrective measures; inventory surveys on pollution of water resources; development of biological methods for determining the severity and extent of pollution; studies of toxicity of water pollutants to aquatic life; development of bio-assay methods and their application to pollution control; development of methods for control of organisms responsible for tastes and odors in water supplies; studies of pollution and purification of shellfish in aquatic environments; determination of radioactivity in surface and ground water and in fresh water life; determination of cyanide in water and wastes. Field investigations of various types of industrial wastes--synthetic rubber, steel, and kraft paper mill wastes and others--have been made.

E. Federal Water Pollution Control Policy and Legislation; 1886-1961.[1]

Almost every Congress during the past sixty years has considered one or more bills relating to the control of water pollution. In the two decades just preceding and following the turn of the Century, the only such bills which actually reached enactment were confined to preventing impediments to navigation. The first was the act passed in 1886 to prevent deposit of refuse matter in New York Harbor. In 1888 this was extended to include certain additional waters adjacent to the harbor, and to cover all matter other than that flowing from streets and sewers in a liquid state. Later, in the 1899 Rivers and Harbors Act, a provisions was included making it unlawful to deposit in any navigable water of the United States specified refuse matter which would tend to impede or obstruct navigation. The provisions of the 1899 law, which is in force today, extend to tributaries and banks of navigable waters, and apply to all refuse matter other than that flowing from streets and sewers in a liquid state.

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[1] Water pollution control literature on policy and legislation is relatively new. Because this material is not readily available, expanded details on policy and legislation are provided in this section.

Although the laws passed in this period were limited to the protection of navigation, and specifically permitted the discharge of sewer wastes, the legislative record during that time gives evidence of concern on the part of some members of Congress in the health aspects of pollution, particularly as related to contamination of public water supplies by municipal sewage.

European developments, coupled with the fact that epidemics of typhoid fever were widely prevalent in this country during that period, undoubtedly provided some of the stimulus for the introduction of several bills, between 1897 and 1909, which called for extensive investigation of pollution of water supplies. As has been indicated, these bills were not passed. From the rather limited record of their consideration, it appears that questions were raised (1) as to the necessity for the Federal government's assuming this type of investigation which might more appropriately be conducted by local governments; (2) as to the agency best fitted to conduct such an investigation, i.e., War Department (which had jurisdiction under previous pollution laws), Public Health and Marine Hospital Service (which was making sanitary investigations under its general health functions), or an independent commission established for the specific purposes of the investigation.

These uncertainties were finally resolved when specific authorization was given, under the broadened functions included in the Act approved on August 14 of 1912, for the Public Health Service to carry on investigations of the pollution of navigable streams and lakes by sewage and other causes.

It should be noted that this authority was limited to investigations. Several bills were introduced providing penalties for pollution revealed by the investigations, but these failed to receive approval.

For several sessions following passage of the 1912 Public Health Service Act, the Congress gave little attention to the pollution problem. The few bills that were introduced--to provide penalties under the 1912 Public Health Service investigation authorization, to prohibit garbage disposal in Federally controlled waters, etc.--remained in the committees to which they were referred, without action. By 1920, however, a new aspect of the problem--oil pollution--had assumed serious proportions. This was due to the increased number of oil burning vessels, increased traffic in oil by sea through tankers, and the discharge of lubrication oils through direct steam use. Severe damage was reported in three principal areas: fish supply and oysters were destroyed; beaches on both seaboards were made unfit for use because of coagulated oil wastes washed up on them, fire hazards at harbors and docks were greatly increased. Sixteen bills and resolutions relating to pollution were introduced during the 67th Congress (1921-22), one concerning acid wastes and the remainder dealing with oil pollution In the 68th Congress (1923-24), thirteen bills were proposed, again one on acids and the remainder on oil. During both the 67th and 68th Congresses there were extensive combined hearings on all the bills, with testimony presented by steamship owners, harbor masters, fishermen, bathing beach owners, fire underwriters, Chambers of Commerce and other interested individuals and organizations.

The 67th Congress approved a resolution which requested the President to call a conference of Nations to consider the advisability of amending the maritime law to provide control over oil pollution of international waters.[1]

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[1] On August 30, 1961, P. L. 87-167 passed the 87th Congress in order to "...implement the provisions of the International Convention for the Prevention of the Pollution of the Sea by Oil, 1954."

The 68th Congress adopted a bill which the President approved on June 7, 1924, entitled, "An Act to protect navigation from obstruction or injury by preventing the discharge of oil into the coastal navigable waters of the United States." This Act, which is known as the Oil Pollution Act of 1924, made it unlawful for any person to discharge, flow, drain, or deposit oil upon or in any of the coastal navigable waters of the United States from vessel, barge or other floating craft or from any shore, wharf, mill, mine, factory or other establishment. Administration of the Act was placed under the Secretary of War.

While this Act was limited to coastal and tidewaters, several of the bills introduced and considered during the 68th Congress covered the inland navigable rivers of the country. These bills sought to prevent the pollution of such rivers by oil from oil fields, oil wells and oil storage. Testimony during the hearings pointed out that such pollution destroys game and fish and endangers health, and called attention to the fact that on interstate rivers it could not be controlled through local actions.

Continued interest in extending oil pollution control to inland waters was evidenced in each of the five succeeding Congress (1925-35) by the introduction of bills having this intent. There were also renewed proposals for prohibiting discharge of acids, a suggestion that the Forest Service conduct investigations to determine practical methods of disposal of pulp and paper mill wastes, and bills prohibiting deposit of refuse to the detriment of navigation, health, or sea food.

Only one of these bills progressed to the hearing state--H. R. 1062 of the 71st Congress. It called for several amendments to the 1924 Oil Pollution Act, including provisions extending the Act to inland navigable waters and the Great Lakes, and adding protection of migratory wild fowl and winter food supply of wild birds to the protection of navigation as a purpose of the Act. Many representatives of conservation groups testified at the hearings regarding damage to wild fowl, fish and recreation. The oil companies, while indicating their desire to cooperate, expressed doubt as to the effectiveness of the proposed measure, and urged that action be postponed to give the industry an opportunity to complete studies then in progress and to present constructive solutions. To the suggestion that other types of wastes be included, and that the oil industry alone not be singled out, the Committee indicated it felt that Federal authority did not go beyond navigability and protection of wildlife.

In December 1934, Senator Lonergan of Connecticut, urged by conservation groups and others concerned with the growing pollution problem called a conference of experts and leaders from various parts of the country for the purpose of recording their views, developing a national program, and making recommendations for its application in the interests of public health, navigation, industrial development, and public works employment. Attending this conference were representatives of interested Federal departments--Corps of Engineers, U. S. Army, National Resources Board, Bureau of Fisheries, Public Health Service, Biological Survey, Geological Survey--of several States, of the Wildlife Committees of the House and Senate, of the Izaak Walton League of America and several State and local chapters, and of the American Society for the Advancement of Science.

After extensive discussions, a subcommittee was appointed to draft a plan for legislative procedure. The subcommittee differed in its views, three of its members favoring a plan calling for an enabling act which would authorize a central governmental agency to form treaties or compacts with the States, and two favoring a similar agency with broad general powers of investigation and enforcement.

Both plans were submitted to all the conferees. Seven were in favor of the first plan, and ten favored the second. Several took an indefinite stand or asked for further conference, but most of these indicated their disposition to favor a plan which could be put under way immediately and which would avoid further delays in making investigations, forming treaties and drawing out enforcement proceedings over a long period of time.

Further active steps were postponed by Senator Lonergan in view of the fact that the National Resources Board, through its Water Resources Section, was then planning definite water pollution control measures in cooperation with Federal, State, and local agencies, and expected shortly to complete initial work on the formulation of specific recommendations to the Congress. However, in January, 1935, the Senator transmitted the recommendations of his Conference to the Chairman of the Resources Board, pointing out that in order to obtain the cooperation of the conferees and the groups they represented, the Board's plan should comply essentially with theirs.

The following year the Senator introduced a water pollution control bill (S. 3958, 74th Congress) substantially in accord with the recommendations of the 1934 conference, making the National Resources Committee, previously created by Executive Order, a permanent agency and placing in it responsibility for administering the provisions of the Act. He also introduced a bill amending the Act of 1899 with respect to the deposit of refuse, to include sludge, acids, and sewage, and Section 13 of the Oil Pollution Act to include discharge from shore establishments as well as vessels.

During that same session, Senator Copeland introduced a bill (S. 4342) creating a Division of Stream Pollution in the Public Health Service, to cooperate with State agencies dealing with water pollution in making studies, coordinating activities, and encouraging uniform laws and compacts. Senator Copeland's bill required that a report be submitted to the President at the close of each fiscal year, and that the President submit the report to Congress with recommendations for further legislation as deemed desirable.

Later in the session, Senator Barkley introduced a series of bills relating to water pollution control, one giving consent of the Congress to an interstate compact for pollution control in the Ohio River Valley, one providing for investigations and reports on pollution by the Chief of Engineers, and a similar bill placing these functions in a Division of Stream Pollution in the Public Health Service and adding provisions with respect to financial assistance to the States for their water pollution control activities. The Conference of State and Territorial Health Officers considered these bills and suggested certain revisions to the one last described. A revised bill incorporating these suggestions was later introduced by Senator Barkley (S. 4627, 74th Congress) and a companion bill was introduced in the House by Representative Vinson.

The provisions of those bills were in many respects similar to those in the Water Pollution Control Act finally adopted in 1948. They provided for preparation of a comprehensive plan for eliminating or reducing the pollution and improving the sanitary condition of the waters of the United States; they required that due regard be given to improvements necessary to conserve such waters and promote their use for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural, and other legitimate uses; they called for encouragement of cooperative activities by the States, enactment of uniform State laws, compacts between the several States; they contemplated grants-in-aid and/or loans for the construction of necessary sewage treatment works.

The Barkley-Vinson bill passed both the House and the Senate, but because a Senator asked for reconsideration in the closing hours of the Congress, the bill died. In the following Congress, the same bill was again approved by both Houses, but was vetoed by the President because of technical defects relative to allocation of grants. The third revision of the bill, considerably changed, was again approved by both Houses in 1940, but when the House later adopted an amendment proposed by Mr. Mundt (then Representative, now Senator from South Dakota), the Senate refused to concur and the bill died. Then came the war, and no serious efforts were made to advance the legislation until 1947.

Early in the 80th Congress, Representatives Spence and Elston introduced identical comprehensive water pollution control bills in the House, H. R. 315 and H. R. 470, and Senators Taft and Barkley jointly introduced a companion bill in the Senate, S. 418.

Representative Mundt also introduced a bill, H. R. 123, which differed in only two respects from the Spence-Elston and Taft-Barkley bills: It provided that no discharge into the streams from new sources of pollution should be permitted without approval of State health authorities, and it provided an "escape clause" to permit granting an extension of time to municipalities not having adequate funds for construction of treatment works, and to industries having wastes for which a method of treatment had not been developed.

The provisions of S. 418 as finally adopted by both Houses, and as signed by the President on June 30, 1948 (P. L. 845), are briefly set forth below, to indicate the framework within which the water pollution control program was carried on from July 1, 1948, to June 30, 1956.

The policy of the Congress embodied in the Act provided for full recognition of the primary responsibilities and rights of the States in controlling water pollution. It also recognized that pollution is a matter of definite

Federal concern as a menace to national welfare, because of its damaging effects on the public health and natural resources.

The Act directed the Public Health Service to develop or adopt comprehensive programs for the solution of water pollution problems in cooperation with the States and with interstate agencies, municipalities, and industries. Such comprehensive programs were to be developed for surface and underground waters, giving due consideration to all water uses--public water supply, propagation of fish and aquatic life, recreational purposes, and agricultural, industrial, and other legitimate uses.

The Act also authorized Federal grants to States and interstate agencies to help them with their industrial waste studies ($1 million a year); grants to States, municipalities or interstate agencies to aid in financing engineering studies and plans preliminary to construction of treatment works ($1 million a year); and loans to municipalities for construction of abatement works ($22.5 million a year). The grants for engineering studies and plans were limited to $20,000 or one-third of the estimated cost of such work; the loans for construction were limited to $250,000 or one-third of the estimated cost of the project.

The Act further provided for Federal research, technical consultative assistance, and encouragement of uniform State laws, interstate compacts and cooperative State activities in the field of water pollution control. Finally, it provided for Federal enforcement, such action to be exercised, however, only on interstate waters, only after the efforts of the States had been exhausted, and only with State consent.

All financial authorizations in the Act were originally limited to a five-year period ending June 30, 1953, but were extended for an additional three years, to June 30, 1956, by the 82nd Congress, 2nd Session, P. L. 579.

Although the Act authorized appropriations totaling $27 million for each year, or $216 million for the eight-year period during which the Act was in effect, a total of only about $11.4 million was appropriated for expenditure through June 30, 1956, of which $8.3 million was for Public Health Service activities (research, comprehensive program development, field investigations, etc.) and $2.9 million for grants to States to aid in their investigations of industrial waste pollution.

A Division of Water Pollution Control was established in the Bureau of State Services of the Public Health Service to accomplish the tasks required by P. L. 845. Using the major drainage basins of the country as a basis of organization, ten small field units were set up. These field offices were located so that they could effectively work with the States in dealing with pollution problems by river basins. The staff of the Division and its field units consisted primarily of sanitary engineers, biologists, and other scientific personnel, having long experience in the operation of State programs, and familiar with the administrative and operating problems of the State agencies. The Robert A. Taft Sanitary Engineering Center in Cincinnati and its predecessor, Environmental Health Center, served as the research facility for water pollution control activities.

During the 83rd Congress, a bill, H. R. 8302, to extend P. L. 845 for two additional years to June 30, 1958, was introduced. The House Committee on Public Works held hearings, but did not report the bill out. The Department of Health, Education, and Welfare did not support the measure because the Administration desired to review and analyze existing legislation and operating experience before making legislative recommendations.

Early in 1955, a bill developed by the Department, on the basis of experience under P. L. 845 and extensive consultation with National organizations representing professional, industrial, conservation, and State government interests, was submitted to the Congress and was introduced as H. R. 3426 in the House and S. 890 in the Senate. This bill provided major changes in P. L. 845, including authorization of matching grants to States and interstate agencies for general water pollution control work (not limited to industrial waste studies); expansion and strengthening of research and investigations; revision of enforcement procedure, including elimination of the requirement that Federal court action to secure abatement of interstate pollution could be undertaken only with the consent or request of the States affected; and elimination of provision for loans for construction of sewage treatment works.

Because of conflicts on these and other amendments that developed in Committee, no conclusive action was taken during the first session of the 84th Congress. In the months following adjournment, representatives of State and interstate agencies and other interested groups held several meetings to consider the pending legislation fully, and develop a common position with respect to proposed amendments, with a view to presenting uniform recommendations to the Congress. These groups agreed to amended versions of the sections on State grants, the Advisory Board, and enforcement, and transmitted them as recommendations to the Subcommittee on Rivers and Harbors, House Committee on Public Works, soon after the second session of the 84th Congress convened. New provisions suggested for consideration during the second session of the 84th Congress included: direction to the Surgeon General to collect and disseminate basic data on chemical, physical, and biological water quality; spelled out specific requirements a State or interstate agency must meet in order to receive grants; authorized grants of $100 million a year, up to an aggregate of $1 billion, for construction of municipal treatment works; and revised the Enforcement Section, requiring the Surgeon General to call a conference of official agencies and to give the appropriate State at least six months' time to take remedial action before holding a hearing.

The Department of Health, Education, and Welfare recommended favorable consideration of either S. 890 or H. R. 9540 (without the construction grants provision) and acknowledged that the provisions of H. R. 9540 relating to the plan requirements for State program grants (Section 5), the composition of the Advisory Board (Section 7), and the procedures governing Federal-State enforcement action in cases of interstate pollution (Section 8), represented improvements over the comparable provisions of S. 890.

In general, representatives of the State water pollution control agencies supported H. R. 9540. There was, however, a divergence of opinion among this group on Section 6, Construction Grants. Many of the agencies took no official position. Others either recommended deletion of the grant provision, modification to provide loans, or expressed complete approval.

The professional organizations endorsed enactment of H. R. 9540, although only one took a position on Section 6, Construction Grants. The Association of State and Territorial Health Officers recommended loans instead of grants as an incentive to construction.

Most of the conservation organizations supported H. R. 9540 but recommended removal of the time limitation and an increase in the appropriation ceiling, with respect to State program grants (Section 5), and recommended amendments to strengthen the enforcement procedure (Section 8).

The industrial organizations generally favored simple extension of the existing Water Pollution Control Act (P. L. 845). With respect to proposed amendments, these groups favored (1) deletion of Section 6, Construction Grants; (2) restoration of the requirement that Federal court action to abate interstate pollution be brought only with the consent of the polluting State; and (3) restoration of the "balance of equity" **clause** in the enforcement section.

The individual cities and the municipal associations endorsed enactment of H. R. 9540, particularly the construction grants provisions (Section 6) and, in general, recommended their liberalization.

Following debate and action in both Houses, the Federal Water Pollution Control Act of 1956 was signed by the President on July 9 (P. L. 660, 84th Congress).

The law authorized a permanent legislative base for the control and abatement of water pollution in a manner that properly preserves the areas of Federal, State and local responsibility. It extended and strengthened the Water Pollution Control Act (P. L. 845, 80th Congress) which expired on June 30, 1956. The new Act was to be administered by the Surgeon General of the Public Health Service under the supervision and direction of the Secretary of Health, Education, and Welfare. The statute:

1. Reaffirmed the policy of Congress to recognize, preserve, and protect the primary responsibilities and rights of the States in preventing and controlling water pollution;
2. Authorized continuous Federal-State cooperation in the development of comprehensive programs for the control of water pollution;
3. Authorized increased technical assistance to States and intensified and broadened research by using the research potential of universities and other institutions outside the government;
4. Authorized collection and dissemination of basic data on water quality relating to water pollution prevention and control;
5. Directed the Surgeon General to continue to encourage interstate compacts and uniform State laws;

6. Authorized grants to States and interstate agencies up to $3,000,000 a year for five years for water pollution control activities;
7. Authorized Federal grants of $50,000,000 a year (up to an aggregate of $500,000,000) for the construction of municipal sewage treatment works, the amount for any one project not to exceed 30 percent of cost or $250,000, whichever is smaller;
8. Modified and simplified procedures governing Federal abatement actions against interstate pollution;
9. Authorized the appointment of Water Pollution Control Advisory Board;
10. Authorized a cooperative program to control pollution from Federal installations.

In 1961, Congress again reviewed the Water Pollution Control Act. New modifications included transferring responsibility for the administration of the Act to the Secretary of the Department of Health, Education, and Welfare; expanded research and authority to construct seven regional water pollution control laboratories; increased grants to States from $3 million to $5 million; increased grants to municipalities to assist in constructing sewage treatment works from $50 million to $80 million for 1962, $90 million for 1963 and $100 million each succeeding year through fiscal year 1967; and strengthened Federal enforcement authority by extending such authority to interstate or navigable waters and defined coastal waters as interstate waters.

F. Low Stream Flow Control.

Early in the twentieth century, it was considered satisfactory to discharge wastes to a river or stream if a calculated volume of dilution water was available, with the expectation that a waterway would, through natural purification processes, cleanse itself. Before World War II there was general agreement that all cities should have at least "primary" treatment, thereby removing about 35 percent of the pollution load and leaving the balance to be treated by the stream. Industries were generally to follow this requirement as well. In addition, where cities, towns, and factories were located on small bodies of water which provided insufficient dilution water, treatment demands were correspondingly higher, 50 percent to to 90 percent treatment of the waste water.

In a few situations, it was possible to store excess flood waters in reservoirs. By controlling the release of this stored water, a suitable balance of waste treatment to controlled dilution water could be maintained. Sometimes this added dilution water could delay the necessity for additional expenditures for treatment works.

Since World War II the Nation's growth, the very large increase in water use, and the increased demand for high quality water to support public health, fish, wildlife, and outdoor recreation have forced the adoption of a new policy about treating our waste waters. In December of 1960 the National Conference on Water Pollution called by President Eisenhower expressed its view that, "the goal of pollution abatement is to protect and enhance the capacity of the (Nation's) water resource to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping waters as clean as possible as opposed to the negative policy of attempting to use the full capacity of water for waste assimilation." (96) This position was reviewed by the Federal Water Pollution Control Advisory Board, appointed by the President, and adopted as its policy at its February 3, 1961, meeting. (97)

This policy recognizes that the Nation's water resources have to be much cleaner than ever before if they are to support the Nation's growing economy and health and welfare goals. But in many places, the best waste water treatment that can be provided will not be good enough, because the science of waste treatment has not advanced fast enough to meet present and foreseeable needs.

The Congress, too, was cognizant of this situation and in the 1961 amendments to the Federal Water Pollution Control Act[1] provided that Federal construction agencies--the U. S. Army Corps of Engineers, the U. S. Bureau of Reclamation, and the U. S. Soil Conservation Service--could store waters in Federally constructed reservoirs for low stream flow control.

While the importance of low stream flow regulation has been an accepted part of the technical aspects of water pollution control comprehensive planning for some years, the ability to consider it in its full economic as well as technical implications became possible only as a result of the amendments to Public Law 87-88. Section 2(b) of the 1961 Act now provides that:

> The Corps of Engineers, the Bureau of Reclamation, or other Federal agency involved in the survey or planning of any reservoir shall give consideration of the inclusion of storage for regulation of stream flow for the purpose of water quality control;

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[1] Public Law 87-88, Amendments to the Federal Water Pollution Control Act of 1961.

Any such storage and water releases shall not be provided as a substitute for adequate treatment or other methods of controlling wastes at the source;

The Secretary of HEW shall provide advice to the concerned agencies on:

(1) The need for storage for the purpose of water quality control; and

(2) The value of storage for water quality control;

The views of the Secretary of HEW shall be set forth in any report or presentation to the Congress by the concerned agencies proposing authorization or construction of any reservoir, including storage for water quality control purposes;

The value of storage for water quality control shall be taken into account in determining the economic value of the entire project of which it was a part;

The costs to be allocated to the purpose of water quality control shall be accomplished in a manner which would insure that all project purposes share equitably in the benefits of multiple-purpose construction;[1]

Costs of water quality control features incorporated in any Federal reservoir or other impoundment under the provisions of the Federal Water Pollution Control Act shall:

(1) Be determined; and

(2) The beneficiaries identified; and

(3) If the benefits are widespread or national in scope, the costs of such features shall be nonreimbursable.

The inclusion of the amendment to regulate stream flows for the purpose of water quality control ended ten years of effort to bring about an improved understanding of the importance of regulating stream flow for quality control purposes and to provide suitable authorizations to make fully effective this vital part of the Nation's water resource development program.

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[1] Under present methods, this means the separable costs-remaining benefits method of computation.

In its 1950 report the President's Water Resources Policy Commission, headed by Morris L. Cooke, restated under post-World War II conditions the importance of giving full consideration to water pollution control in the Nation's rapidly expanding water resources development program. In 1951, the Bureau of the Budget established a Review Committee to consider in detail the recommendations of the Cooke Commission; to consider the implications of the recommendations with respect to existing programs and legislation; and to determine a recommended course of action to implement them. A subcommittee of the Review Committee concerned with water supply, recreation, pollution, and fish and wildlife, in connection with Recommendation 2[1] of the Cooke Commission report dealing with costs of pollution abatement, added an explanatory note to the recommendation. This note stated, "no reimbursement should be required for pollution abatement by stream dilution because such reimbursement would: (1) relax the pressure on community and industrial firms to construct primary treatment works, and (2) cause serious difficulties in periods of low flow."[2]

These discussions in the Review Committee deliberations considering stream regulation for pollution control on a non-reimbursable basis helped focus attention to this aspect of water resources development.

This subject was again considered in draft legislative proposals during 1952 and, as a result, was again brought to the attention of a wide audience in Federal departments as well as concerned Congressional committees dealing with water resources programs. The draft of the "Water Resources Policy Act of 1952" included a statement under "Reimbursements Concerning Water Pollution," as follows:

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[1] President's Water Resources Policy Commission, 1950. Vol. I, Chapter 13, Pollution Control, p. 195.

[2] Unpublished minutes of the subcommittee on water supply, recreation, pollution, and fish and wildlife of the Bureau of the Budget Review Committee on the President's Water Resources Policy Commission Report of 1950, dated August 14, 1951.

> Total Federal costs allocated to pollution control or abatement through streamflow dilution shall, to the extent that such dilution effectively replaces and makes unnecessary specific treatment measures which would otherwise be required, as determined by the Secretary after consultation with the Federal Security Administrator, be reimbursed by the local governments, districts, persons, or others who would be responsible for such treatment measures.[1]

In commenting on this draft proposal, the Federal Security Agency indicated that it had no particular quarrel with the principle underlying this specific language. However, the Agency anticipated considerable difficulty in its application to actual situations. The difficulty of differentiating between the reimbursable costs which would be allocated to pollution abatement through streamflow dilution and reimbursable costs properly allocable to other purposes benefiting from the same dilution (recreation, fish and wildlife conservation, water supply) was pointed out to the Bureau of the Budget. The Agency further noted that, even if an assumption was made that these costs can be allocated as between these several closely-related uses, the problem is further complicated by the fact that the same stream dilution which results from water pollution benefits also benefits downstream users for such purposes as recreation and fish and wildlife, although those beneficiaries will not share responsibility for reimbursement. They concluded, therefore, that agreements for reimbursement of this character solely from beneficiaries of pollution control would be difficult to negotiate. In conclusion, the Agency pointed out that, while the general principle that the cost of pollution abatement ought to be borne by those responsible for pollution had been accepted for many years, and while the Agency subscribed to this principle, its inclusion in the proposed bill in the matter of reimbursement of the cost of stream flow dilution would not be readily acceptable, and would cause considerable controversy.[1]

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[1] Unpublished draft Water Resources Policy Act of 1952, revised May 29, 1952. This draft Act was proposed to implement the Cook Commission's findings.

During late 1953, the Bureau of the Budget considered revising its Circular A-47 establishing standards and procedures to be used by the Executive Office of the President in reviewing proposed water resources project reports and budget estimates. Under law prevailing at that time, the Bureau of the Budget Circular continued to propose that allocations of cost to pollution control were to be limited to those costs which would be fully reimbursed by the States, local governments, districts and others.

In proposals to the Bureau of the Budget, the Department of Health, Education, and Welfare proposed first, a basic principle with respect to stream flow regulation for pollution control and, additionally, a new section to be included in Circular A-47 relating to additional standards for low flow regulation for water pollution control to protect public health, recreation, agriculture, fish and wildlife, and industrial water supplies. With respect to the first item, the Department stated, "It would seem that the basic principle involved in the development of water resources and standards pertaining thereto involving dilution water for disposal of wastes should related not solely to the matter of reimbursement for benefits which may accrue due to increased dilution water being made available, but rather to the protection of the water resources of the Nation through the proper utilization of water resources developments in which the Federal government participates. In the final analysis, the best purpose will be served if the standards of the Federal government provide for those developments which will stimulate or otherwise insure that water resources developments will protect public health and, through pollution control, other water uses and their accompanying water quality requirements."[1]

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[1] Correspondence between Acting Administrator John L. Thurston, Federal Security Agency, and Frederick J. Lawton, Director, Bureau of the Budget, May 5, 1952.

With respect to the second item, additional standards pertaining to low flow regulation, the Department proposed that such low flow regulation and its effects should be given full consideration in the preparation and evaluation of water resources programs and projects; that minimum flows necessary for pollution control were to be considered as necessary adjuncts to the construction of Federal projects and that agencies reporting on programs or projects should include in their report a statement of the effect that water control and regulating devices would have on minimum flows and the effects of these flows on pollution control as it affected all water uses. In addition, the Department suggested that any report of a program or project having significant effect on public health or other water uses as a result of minimum flows caused by the project or program should include a statement of the views of the Secretary of the Department of Health, Education, and Welfare on such aspects. The Department further suggested that the costs of providing augmented flows for pollution control purposes should be prepared and that the Congress should be informed of the maximum amount of costs which were proposed to be borne by the Federal government for augmenting stream flows for pollution control benefits.

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[1] Letter from Acting Secretary Nelson Rockefeller to Mr. Roland Hughes, Deputy Director, Bureau of the Budget, December 30, 1953.

The Department also proposed that the costs of surveys and investigations and planning required to provide for a full and complete evaluation of low flows and their effects be undertaken as a nonreimbursable Federal expense. Finally, the Department proposed criteria to be used in judging whether the Federal interests were sufficiently adequate to recommend nonreimbursement for low flow control benefits.

Because of differences between the Congress and the Executive Office of the President during the period 1953 through 1958, no further efforts were made to revise the Bureau of the Budget Circular A-47 on this or other matters.

In 1956, Congress, in Section 205 of the Rivers and Harbors bill of that year,[1] proposed that,

> In prosecuting plans and projects for navigation, flood control, and allied purposes heretofore or hereafter authorized, storage may be included in any reservoir project to be constructed by the Corps of Engineers without reimbursement to increase low flows downstream to the extent warranted at that time, or anticipated to be warranted at that time, or anticipated to be warranted during the economic life of the project, by widespread, general, and non-exclusive benefits from such increases in low flow.

The purpose of this section, according to the House Committee on Public Works,[2] would permit

> ...the Corps of Engineers to incorporate, in reservoirs to be constructed by the Corps, storage for low flow augmentation under certain conditions and with certain restrictions. This is a much needed provision to permit the optimum development of the Nation's water resources and will correct the present situation which sometimes results in the construction of reservoirs which do not take full advantage of the potentiality of the stream flow.

This Act was vetoed by President Eisenhower since it failed to meet his standards for reviewing new projects and for other reasons.

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[1] U. S. Congress, House of Representatives, H. R. 12080, July 7, 1956, 84th Congress, 2nd Session.

[2] U. S. Congress, House of Representatives, Committee on Public Works, Report on H. F. 12080.

In 1955 and 1957, staff documents[1] outlined the position of the Water Supply and Water Pollution Control Program of the U. S. Public Health Service. These reiterated the policy position taken by the Department of Health, Education, and Welfare with the Bureau of the Budget in 1953 and helped to develop increased awareness of the value of low stream flow control.

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[1] L. B. Dworsky and M. LeBosquet, Water Pollution Control, staff paper, Water Supply and Water Pollution Control Program, Public Health Service, U. S. Department of Health, Education, and Welfare. August, 1957, p. 4:

> Water Resources Development
>
> In both planning and operation of water resources projects, it is essential that full consideration be given to the effects that regulation of stream flow has on public health and on beneficial water uses. Reimbursement and cost allocation practices are needed which will facilitate provision of adequate minimum stream flow.
>
> Additional development of the Nation's water resources continually enlarges the area of regulated streams and waterways as against naturally flowing streams. Sewage and industrial waste treatment works are designed with consideration as to the stream flow conditions that exist in the water courses into which they drain. The governing criterion as to the type of treatment works to be constructed is the low-flow record of the water course. If the natural low flow in a stream is reduced, sewage treatment works designed on the basis of the unreduced natural low flow may prove inadequate and the benefits expected from construction of the treatment works may be reduced or lost.
>
> With reference to reimbursement and cost allocation practices, Section 11c(2) of Budget Bureau Circular A-47 provides that: "Allocations of costs to pollution control or abatement shall be limited to those costs for that purpose which are to be fully reimbursed by the States, local governments, districts, or other interests concerned, including other Federal establishments."
>
> It would seem that the basic principle involved in the development of water resources and standards pertaining thereto involving dilution water for disposal of wastes should relate not solely to the matter of reimbursement for benefits due to availability of increased dilution water, but rather to the protection of the water resources of the Nation through the proper utilization of water resources developments in which the Federal Government participates. The best purpose will be served if the Federal standards are such as to insure that water resources developments will, through pollution control, protect public health and the water quality requirements of other water uses.

On April 20, 1959, the 86th Congress approved Senate Resolution 48 establishing the Senate Select Committee on National Water Resources, known as the Kerr Committee. In the course of its extensive hearings throughout the Nation during 1960, the Committee heard comments of officials and citizens on nearly all problems of concern to the Nation's water resources development programs. During field hearings, two statements were provided to the Committee dealing with the problem of low stream flow control for water quality management purposes. The first was a statement by the Pacific Northwest Pollution Control Council (98) representing the States of Washington, Oregon, Montana, Idaho and Alaska, the Secretary of which was the Officer-in-Charge of the Public Health Service's Water Supply and Pollution Control Program located in Portland, Oregon. The second was a statement by Senator Maurine Neuberger in the Washingtin, D. C., hearing in May of 1960. (99)

In presenting this matter to the Committee, Senator Neuberger described the problem.[1]

> There is a direct relationship between water quality and streamflow. Water quality is usually adversely affected by extremely low water flows, especially during periods of high temperatures. Increasing the flow in streams particularly during periods of low flow would bring about a general improvement in the quality of waters under regulation. This is particularly important to fish and wildlife and other aquatic life, to municipal and industrial water supplies, to the protection of public health, and to the recreational use of waters. With respect to water quality for all of the above purposes, except fish and wildlife, the Federal water resources construction agencies do not have general authority to consider this problem as an authorized function and to study and make recommendations of flow augmentation provisions in Federal projects. (99, p. 3489)

Senator Neuberger summarized the legislative need to meet this problem:

> Consideration should be given to the provision of general authority to the Federal construction agencies to include low flow augmentation as

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[1] Senator Neuberger adopted the position of the Pacific Northwest Pollution Control Council on this matter.

> an authorized function in planning water development projects. Because benefits from low flow augmentation are general, widespread, and nonspecific, the provisions required to provide them should be considered as nonreimbursable in Federal projects.
>
> It is further recommended, that the Secretary of the Department of Health, Education, and Welfare, through the Public Health Service, be authorized to cooperate with the Federal construction agencies in the development of low-flow augmentation programs since the net effect of these programs is to control and improve water quality; and further that the Secretary of the Department of Health, Education, and Welfare be required to submit reports to the Congress to accompany Federal construction agency reports insofar as low-flow augmentation programs are concerned.
>
> It is recognized that the Fish and Wildlife Service Coordination Act of 1946, amended in 1958, authorizes the Fish and Wildlife Service to undertake similar responsibilities with respect to fish and wildlife. The authority suggested in the above recommendation should supplement the fish and wildlife service program by considering all other aspects benefited by flow augmentation including, of course, effects upon humans.
>
> There is one important policy point with respect to this matter. The provision of augmented flows is not to be used for the abatement of water pollution in lieu of full and complete sewage and waste treatment facilities by cities, industries, or others concerned. (99, p. 3490)

The recommendations of the Senate Select Committee on National Water Resources, reported January 30, 1961, (100) while noting the importance of future demands on the Nation's relatively fixed water supply, emphasized the greater importance of "maintaining water quality through pollution abatement in order that increased reuse of water will be possible, and to improve conditions for recreation and for conservation of fish and wildlife to support increased leisure time activities of the people." (100, p. v)

The basic elements of a program to enable the Nation's needs for water to be met, the Committee stated, are "storage facilities to increase the low flow of rivers and sewage and industrial waste collection and treatment facilities to maintain the necessary quality of water." (100, pp. v-vi) The costs estimated for the Committee of this program were $12 billion for storage and $42 billion for waste collection and treatment, a total of $54 billion to meet requirements by 1980.

This conclusion of the Committee was reflected in its Recommendation No. 1 relating to the development of comprehensive plans for all major river basins of the United States. The Committee indicated that such plans should take into account prospective demands for all purposes served through water developing, giving "full recognition to non-revenue-yielding purposes such as stream flow regulation...." (100, p. 17)

Early in the 87th Congress, the Senate Public Works Committee had for consideration S. 1475, a bill proposed by Senator Long (La.) to amend and strengthen the Federal Water Pollution Control Act to provide for flow regulation for water pollution and quality control and other purposes. This bill proposed a major change in the functions and responsibility of the Surgeon General of the Public Health Service. For example, the Surgeon General would be required, after taking into account plans of all other Federal, State, interstate, and local agencies and other interests, to compute present and future requirements for water releases from Federal reservoirs necessary to maintain water quality and control pollution in the navigable waters of the Nation. In addition, the Surgeon General would be responsible from time to time to report to the Congress the portion of storage capacity of specific Federal reservoirs necessary to maintain water quality and control water pollution in the Nation's waterways. Finally, and after only consultation with Federal, State, interstate, and local agencies and other interests involved, the Surgeon General, the bill proposed, would determine and promulgate conditions under which releases from Federally constructed reservoirs would be made in order to control water pollution and maintain water quality. Such releases for this purpose were to be made on the basis of need as determined by the Surgeon General; and the operators, such as the Corps of Engineers, and the Bureau of

Reclamation, upon written request of the Surgeon General or his designee, would be required to release waters determined by the Surgeon General to be needed for quality control purposes.

Public Law 87-88, amending the Federal Water Pollution Control Act, did not reflect these suggested major shifts in responsibility to the Surgeon General in connection with water quality control functions. The bill enacted by Congress[1] instead stayed close to the policy and specific language proposed from time to time by the Department of Health, Education, and Welfare in their staff documents. However, the thoughts contained in the bill proposed by Senator Long (S. 1475) are indicative of the importance of water quality control in the water resources development program of the Nation. It might well be considered an early view of the ultimate position of water quality management in our water resources development programs.

G. Water Supply.

Water supply for cities and industries has traditionally been a matter of local and State concern within the context of the Federal water resources development program. Where assistance has been provided to State and local governments in connection with municipal and industrial water supplies, provision has been made for considering such water supplies as vendible products and full reimbursement for the costs of including such supplies in Federal reservoirs has been the established Federal policy.

Stimulated again by the studies of the President's Water Resources Policy Commission in 1950, draft legislation proposed for consideration during 1952[1] continued this principle of full reimbursement for municipal and industrial water supplies. However, the draft act recognized the growing importance of water supplies for cities and industries and included a provision providing that, "reimbursement of such costs resulting from the design or construction of enlarged facilities intended to serve future expanded demands may be deferred until such capacity is utilized." This break with precedence gave recognition to the need for considering future recommendations but for which contracts could not be developed with local or State bodies at the time of the development of the Federal project.

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[1] Unpublished draft Water Resources Policy Act of 1952, revised May 29, 1952.

During 1953, in considering revisions to its Circular A-47, the Bureau of the Budget proposed maintaining the general principle of local and State responsibility for municipal and industrial water supplies development. However, it also considered extending the provisions of use of Federal multi-purpose reservoirs to satisfy growing demands through more efficient use of the limited reservoir sites in the Nation as well as to meet the projected municipal and industrial water supply demands. The Bureau of the Budget proposed to do this by authorizing first, recognition of the fact that anticipated future needs for municipal and industrial water supply could be provided in Federal multi-purpose reservoirs up to 15 percent of the total construction cost of the program or project; that all financial costs for such provisions be repaid within 50 years after the date of the initial use of the additional storage; that reasonable assurance be given by local interests that the water supply storage would be used within no more than ten years following the initiation of the project; and that a repayment contract be signed prior to the beginning of construction indicating an agreement to start repayment within the ten-year period.

The Department of Health, Education and Welfare, in commenting on this proposal,[1] indicated their concurrence with the general principle of local and State responsibility for municipal and industrial water supplies. However, the Department stated that restricting the future water requirements portion of the project to not more than 15 percent of the construction costs is not in the best interest of proper development of water resources for necessary uses. The Department further stated that the 15 percent should be used solely as a guideline but that additional language should be included allowing anticipated future needs to be included to the extent necessary to provide for the best possible water development program. The criterion controlling the amount should be the satisfactory justification of the project in terms of cost and benefits within the framework of the standards established in other parts of Circular A-47.

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[1] Letter from Acting Secretary Nelson Rockefeller to Mr. Roland Hughes, Deputy Director, Bureau of the Budget, December 30, 1953.

Continued high interest in the water problem, a high rate of urbanization and unprecedented industrial development, especially during the Korean build-up, resulted in more and more attention being paid to the possibility of municipal and industrial water supplies. The several severe droughts during the middle part of the 1950 decade gave further impetus to the need for doing more to meet the demands for water by cities and industries.

In 1958, Congress enacted the Water Supply Act of 1958 as Title 3 of Public Law 500. This Act was a major step forward in recognizing a new Federal responsibility to help meet these water supply requirements. The Act provided for greater utilization of waters stored in Federal multi-purpose reservoirs. While the Act clarified some of the previous policies with respect to repayments for municipal and industrial water supply contracts, its major contribution was a provision allowing Federal agencies to plan and store water for anticipated future requirements of cities and industries. Such plans could be carried forward if reasonable assurances were provided by cities and industries that the waters so stored would be utilized within a ten-year period. At the time that the waters were utilized, a contract would then be developed calling for repayment of the costs of the water supply during the life of the project.

Because of the untried character of the new Water Supply Act of 1958, questions were raised as to the extent of reasonable assurances and what would be accepted as reasonable assurances. Because of these questions, the Congress, in an amendment to the Water Pollution Control Act of 1961 (P. L. 87-88) clarified the Water Supply Act of 1958 with respect to the amount that could be allocated for anticipated future water supply requirements and clarified the matter of reasonable assurances. The Committee report commenting on the matter of assurances stated that:

> The present law provides authority for the Corps of Engineers and the Bureau of Reclamation to include municipal and industrial water supply capacity in reservoirs under their jurisdiction. The present law, among other things, provides that not to exceed 30 percent of the total cost of any project may be allocated to anticipated future demands where State or local interest give reasonable assurances that they will contract for the use of storage for anticipated future demands within a period of time which will permit paying out the costs allocated to water supply within the life of the project. The latter provision in many cases places an undue and undesirable restriction on the inclusion of capacity for future use, because of the inability of many communities, and perhaps even States, to assume the contractual obligations implied. Therefore, in order to permit optimum utilization of the limited number of good dam and reservoir sites remaining, the requirement for the communities or States, with respect to contractual arrangements, should be liberalized. Accordingly, the amendment, although still requiring reasonable assurances of the use of storage for future water supply, would permit the Federal agency concerned to make its own determination of future water supply needs and, on the basis of such determination, may include capacity without definite contractual commitments from State or local interests. It is the intention of the committee that the Federal agency concerned would make appropriate allocations of reservoir capacity for present demands and determine the progressive increments which should be placed in the present demand category from the future demand reserve. (101, p. 9)

As a result of the efforts largely developed between 1950 and 1960, the decade closed with the addition of two substantial functions to the water resources development armament of the Nation. Functions dealing with the control of water quality and the provision of waters for cities and industries are now recognized as being among the major water resources development problems facing the Nation during the coming decades. The new legislation makes a strong start in meeting these rapidly emerging needs.

3. Metropolitanism and Industrialization.

In discussing the Industrial Revolution, which he terms The Rise of the Empire of Machines, Barnes (40) makes it clear that the nature of present-day social problems cannot be conceived unless we understand the historical perspective of our age. He describes the Twentieth Century as "a novel era in the development of humanity, like unto the passage from preliterate culture to the dawn of history and the rise of civil society; the breakup of the Roman Empire and the dawn of medievalism; or the transition from medieval civilization to modern times between 1500 and 1800." (40, p. 1)

The Industrial Revolution was a complex series of events affecting not only industry, but agriculture, transportation, communication, social controls and urbanization. (84, p. 50) The development of machines and the factory system demanded great quantities of labor close to the machines. As a result, urban population increased tremendously. At the same time, agriculture was making great strides in greater productivity and for the first time was able to support large masses of people in urban centers. Out of these basic factors began the rise of industrial cities and the development of urban civilization as we know it today.

Barnes, however, warns that there are great differences between this urban civilization and the great cities of history. "City life as an experience of the majority of the population is a novelty, the results of which cannot yet be foreseen." (40, p. 21)

As the industrial cities developed, new problems developed, while older problems intensified. Congestion of population, bad housing, and epidemic disease were inevitable consequences of the rapid and haphazard urban development.

The growth of sanitary engineering, the scientific means of dealing with sewage, garbage, and rubbish and the provision of healthful water supplies, mainly a product of very recent history, has had a very important impact on the development of the modern city.

The Rise of Cities in the United States: The growth of cities has come about at a rapid pace in the United States. As previously noted, in 1800 there were no cities of 100,000 inhabitants. By 1950 there were 150 metropolitan districts ranging from 100,000 to 13 million people in size. Factors in the transformation included rapidly growing population, not only during the periods of high immigration but during the last forty years as well, the rapid advances in industrialization, the movement of rural people to urban centers, and the substantial surplus of births over deaths in the urban areas.

McKenzie suggests three periods in which urban development progressed with respect to transportation forms. (85, Ch. 1) Up to 1850 most developments took place along the seacoast, lakes, and navigable rivers. Next with the rapid westward expansion of railroads and the occupation of new land, cities developed at junctions and convenient shipping centers. The third period, from 1900, was characterized by the development of regionalism; the development of wholesale and retail trade, the marketing of farm produce, and the distribution of manufactured goods.

Urban communities in the U. S. (places with 2,500 or more inhabitants) increased their proportion from 35.4 percent of the total population in 1890 to 57.4 percent in 1950. The number of cities with 100,000 or more inhabitants rose from 28 in 1890 to 93 in 1930 and 106 in 1950. The decade of the 1930's represented the only period when there was no increase in the number of large cities or in the total population in such cities. Thus, the process of city growth had come temporarily to a standstill while the trend to urbanization (growth in area around city) continued. During the 1940's there was again a rapid growth of population in large cities of from 100,000 to 1,000,000 population. (20, p.124) However, the rate of change with respect to total urban development (cities plus the suburban areas) was slower.

The Rise of the Metropolitan Region. As the modern city developed, there resulted a set of reciprocal relationships between it and the surrounding region. The modern city, in its very nature, creates a drain and continues to drain the region around it of its population and natural resources. Surpluses of material, both agricultural and fabricated, flow through urban centers, where they are exchanged as commodities of commerce. (86, Ch. 6) In turn, it creates an efficient and effective arrangement for providing work; it makes possible considerable freedom of choice in choosing the kind of work one desires; it provides essential sanitary, health and welfare services whose effects are often felt beyond its own boundaries; it provides the centers of culture, entertainment and recreation and the development of facilities for communication between the city and its surrounding area and among cities.

Factors Underlying Metropolitan Development. While the suburbs of American cities have been developing over a long time, by 1900 in the United States, there began to be a noticeable concern by cities of the developments outside of their boundaries proper. The reason for extra-city development is thought (86, p. 12) to rest in the desire of the people to have the advantages and escape the disadvantages of both country and city; to have the fresh air, sunshine, open spaces and natural surroundings which were becoming less available in the city but at the same time to enjoy the resources, convenience, opportunities and services which only cities can afford to provide.

Suburbanization. The chief reason given by Douglass (87, pp. 44-52) for the growth of suburbs is that homes and industries are crowded out of cities. There is a relationship between size of city and extent of suburbs and between size of suburbs and rate of growth. In general the movement of people is from places of high density to places of low density.

There is a very great variation in response to population pressure. Hallenbeck (86, Ch. 12) notes four factors which facilitate the development of suburbs in American cities. The first is psychological. If people are not aware of what constitutes good housing and healthful surroundings; if they are not aware of the nervous strain brought on by traffic congestion, noise and overcrowding--there is no motivation for change. But the dissemination of knowledge with respect to these matters in recent years, the reiteration of the advantages of escaping these conditions has increasingly been brought before people.

A second factor has been transportation and communication. The ability to get to places of work rapidly and to keep contact with the city through daily delivery of newspapers, telephone and store delivery service has made suburbanization less difficult.

A third factor is the advanced stage of community development; the provision of facilities, goods and services within the new community itself. Thus food shops, stores, churches, schools and the like, operating within the community stimulate the shift to suburban living.

The fourth factor is the cost of living in the suburbs. Formerly thought suitable only for higher income families, in recent years moderate income families have been able to take advantage of suburban living through having projects, resettlement projects, new mass production techniques for constructing housing and the new financing techniques, largely involving government support through insurance or guarantee procedures.

In addition, Hollenbeck outlines four particular characteristics of suburbs. These are (1) that fewer people occupy more land; (2) that suburbs decentralize only a fraction of a city's total functions and so are fragmentary and dependent communities; (3) that there are fewer major institutions than in independent towns of the same size and (4) that means for going to the city and getting back and forth must be readily accessible and convenient.

Decentralization.[1] (88) During the decade 1930-40, some of the largest cities in the United States grew at a much slower rate than the Nation as a whole. This was a reversal of trend since, prior to 1930, these cities had grown at a rate in advance of national growth. While the cause of this situation is not known, two proposals have been advanced to explain it. These are (1) that the decline was due to the depression and (2) that the metropolis (city) is entering upon a new stage of development and that a process of "decentralization" has set in. (89, pp. 297-307)

Prior to 1930, population movements from cities to nearby suburban areas had attracted considerable attention. It was assumed that the inward population flow created in turn outward pressure into the area around the city and was not considered at first a threat to the city. Industrial and commercial growth at the center also displaced population outward. In general, the external movement was believed to be due to a "spilling over" effect due to large in-migrant movement toward the city. But during the 1930's, when in-migrant pressure was at a minimum of close to zero, the trend outward did not diminish. It became apparent that the center of the city was no longer deemed the most desirable location for residence, for many types of industry and commerce. The urban economy appeared to be oriented toward a new pattern, and if it continued for a long period of time, would lead eventually to the breaking up of the compact metropolis and the central business district and the establishment of new and more dispersed patterns of urban areas.

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[1] Most of the material in this section is from Mr. Bogue's study cited in reference (88).

These observations led to the hypothesis of urban decentralization. The basic essentials of this theory are not only that suburbs are growing faster than the central city, or that the physical ground structure of cities is changing, but the idea that _the competitive and cooperative relationships of the metropolis with the areas surrounding it are undergoing a fundamental change._

Based upon technologic change which provides more freedom for location of industry and commerce, it is thought by students of the problem that the great population flow toward cities is unnecessary and may actually lead to a literal "decentralization" of our greatest cities.

Defining Metropolitan and Urbanized Areas. The result of the process of suburbanization and decentralization has been the development around cities of a larger community of which the city is the center. Beginning in 1910, the U. S. Bureau of the Census recognized these larger "communities" and for the first time issued a report dealing with "Cities and Their Suburbs". The 1920 Census used the 1910 basis of enumerating cities and their larger external communities. The 1930 and 1940 censuses adopted the definition of a central city and contiguous area having a density of 150 per square mile, with the exception that the 1940 Census included all cities of 50,000 population or more as the basis for determination.

The 1950 Census introduced two new major area concepts; (1) The Standard Metropolitan Area[1] and (2) The Urbanized Area.[2] These changes, along with others, were made to resolve numerous outstanding problems in the use of population and other economic and social data. It is now believed that the 1950 definitions will permit the orderly gathering of meaningful statistics for metropolitan areas for a long period of time.

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[1] Standard Metropolitan Area Definition:

Except in New England, a standard metropolitan area is a county or group of contiguous counties which contains at least one city of 50,000 inhabitants or more. In addition to the county, or counties, containing such a city, or cities, contiguous counties are included in a standard metropolitan area if according to certain criteria they are essentially metropolitan in character and socially and economically integrated with the central city.

In New England, the city and town are administratively more important than the county, and data are compiled locally for such minor civil divisions. Here towns and cities were the units used in defining standard metropolitan areas, and criteria relating to the number and proportion of nonagricultural workers set forth above could not be applied. In their place, a population density criterion of 150 or more persons per square mile, or 100 or more persons per square mile where strong integration was evident, has been used.

[2] Urbanized Areas Definition:

"Urbanized Areas" have been defined for the first time in the 1950 Census. The major objective of the Bureau of the Census in delineating these areas was to provide a better separation of urban and rural population in the vicinity of our larger cities than was possible under the old definition. All persons who resided in urbanized areas on April 1, 1950, are included in the urban population according to the new definition. The effect of the adoption of the urbanized area concept was to include in the urban population 6,203,596 persons living under distinctly urban conditions in the immediate environs of our larger cities who under the old definition would have been included in the rural population.

An urbanized area is an area that included at least one city with 50,000 inhabitants or more in 1940 or later according to a special census taken prior to 1950 and also the surrounding closely settled incorporated places and unincorporated areas that meet the criteria listed below. Since the urbanized area outside of incorporated places was defined on the basis of housing or population density, its boundaries for the most part are not political but follow such features as roads, streets, railroads, streams, and other clearly defined lines which may be easily identified by census enumerators in the field.

Pattern of Metropolitan Growth Based Upon 1950 Census Data. Recognizing the serious, although not necessarily bad, implications to the Nation of the developing trends in metropolitan growth, the Federal government sought to further increase the available knowledge on the problem. This they did by supporting a study on Population Growth in Standard Metropolitan Areas, 1900-1950. (90) A summary of parts of the analysis deemed useful to this study is provided in the following paragraphs.

> Sources of Metropolitan Growth. The growth of the metropolitan population has not been due to the addition of new area alone but to the continuation of extraordinary rapid rates of growth in already established S.M.A.'s.[1]
>
> Growth in Central Cities and Rings. For the two decades, 1930-1950, central cities have grown less rapidly than the population of the Nation, and only about one-third as rapidly as their own rings. This can only mean that such growth as they have made was largely self generated by an increase of births, over deaths (natural increase). Many cities, if not most, have suffered rather large net out-migrations both during the depression 1930's and the prosperous post-war 1940's.
>
> Growth of Urban and Rural Areas within Metropolitan Rings. Within the rings of S.M.A.'s, there has been another reversal of the pattern of growth, similar to that which occurred between central cities and rings. Before 1930 urban places in the rings were growing much more rapidly than the rural areas.... During the 1930-40 decade, however, this situation was completely reversed, and this reversal has continued through the 1940-50 decade. During the last 20 years, the growth of incorporated places into the urban class has slackened noticeably, while the suburbanization of unincorporated territory adjacent to metropolitan centers has been accelerated tremendously. Thus, the great upsurge of population into the periphery of S.M.A.'s during recent decades has not gone heavily into outlying urban centers, as in 1900-30. Instead, it has gone primarily to the unincorporated and less densely settled parts of the rings. The 1940-50 decade merely continued this tendency which became the dominate pattern through the depression years.

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[1] Standard Metropolitan Area.

> Size as a Factor In Metropolitan Growth. With the exception of a general tendency for S.M.A.'s of one million inhabitants or more to grow at a slightly less rapid rate than S.M.A.'s smaller than this, there has been no pronounced or consistent trend for rates of total metropolitan growth to vary with size, either in the 1940-50 decade or in any earlier decade.
>
> Regional Variations in Metropolitan Growth. Region of location is a factor in metropolitan growth. This is not a recent phenomenon but one of long standing.... Whereas S.M.A.'s as a whole grew by 21.8 percent, those in the Northeast grew only by 10.3 percent.... S.M.A. growth in the North Center region has been near the national average rate.... In the 1940-50 decade, the South increased its S.M.A. population at the comparatively rapid rate of 35.6 percent, or more than 50 percent faster than the average rate of metropolitan growth in the nation.... These are the fastest rates of growth which the South has enjoyed since 1900 or possibly much earlier. They are faster rates of growth than those which prevailed in the Northeast and the North Center during their period of metropolitan expansion.... Growth rates of S.M.A.'s in the West have been about twice the rate of growth for all S.M.A.'s. This region, which has experienced a great influx of population at each decade since 1900, has not failed to settle at least one-half of its total regional increase in S.M.A.'s.
>
> Size of S.M.A.'s and the Growth of Rings. In general, central city rates of growth have been lower in recent decades in large S.M.A.'s than in small.... The rate of growth of the rings tends to have no systematic relationship to the size of the S.M.A..... The larger the S.M.A., the More rapidly the ring has been growing in comparison to the central city.... Thus, although the total growth of S.M.A.'s was earlier shown to bear no simple relationship to their size, the internal patterns of growth and distribution do vary with size.
>
> Regional Variations in Ring Growth. The most decentralized growth is occurring in the Northeast and North Center regions, whereas the least decentralized growth is occurring in the South and West.... The tendency toward a greater rural than urban growth since 1930 is much more pronounced in the Northeast than in the other regions. To date it has been entirely absent in the South.

Types of Communities within a Metropolitan Area. (84, p. 113) Queen outlines seven types of metropolitan communities. The seven types are: (1) outlying communities having a relatively independent social and economic life from the rest of the metropolitan area; (2) outlying communities with a measure of self sufficiency but with definite relations to the central city; (3) parts of the continuous built-up portion of the metropolitan area with local institutions and names but less sharply defined. These are easily identified when set apart by natural or artificial barriers but often there are no distinguishing marks. Such parts might have been of types (1) or (2) above but with the centrifugal build-up from the Central City, the part and the Central City have grown together. These types may be incorporated or unincorporated; (4) parts adjacent to the Central City created to attract or provide for the overflow of urban population. These may be incorporated or unincorporated or in some cases, may occupy otherwise unoccupied land within the Central City; (5) industrial communities, frequently built around one or a group of large manufacturing establishments; types (6) and (7) stem from types (3), (4) and (5). Type (6) represents suburbs which are drawn closer and closer to the Central City and through annexation become politically a part of the City; and (7) the final stage wherein the separate area is integrated politically and culturally into the Central City and all separate differences disappear.

Competing Uses for Urban Land. The sharply expanding metropolitan community has grown and continues to grow at the expense of rural lands. Since World War II the problems of transition from rural land use to urban use have become acute. In making the transition, important social conflicts also occur. The urban people moving into the farmer rural land demand urban services, urban school standards, urban roads and transportation. Rural people fear higher taxes and tend to resist the encroachment on their rural living pattern.

As the urban fringe stretches out to meet the rural area lands may tend to be limited in use or referred in greater degree to rural land zoning. As reported in 1953, 38 states had passed enabling legislation authorizing the zoning of rural land by counties, townships or other local subdivisions. By 1950 about one-third of the counties had been empowered to zone and zoning ordinances had been passed in 173 counties. Many of these zoned areas included the rural-urban fringe of metropolitan communities. As more rural land is needed for urban use, it is probable that more rural zoned land will come in contact with urban expansion. If rural zoning holds its ground, it may slow the rate of indiscriminate urban growth and force such growth into a more logical pattern.

Special purpose areas demand much ground in the urban-fringe areas. These purposes are usually for roads and streets, recreation (such as parks, golf courses and forest preserves) and airports. The increasing requirements resulting from improved and expanded transportation and greater leisure time will tend to continue to aggravate the urban-rural land use question in the metropolitan areas.

Central City, Urban-Fringe Water Supply Relationships. Nearly 70 million people live in the Nation's 157 urbanized areas. Of these, nearly 50 million live in the Central Cities of 50,000 population or more. In general, the larger the urbanized area, the larger is the population living outside the Central City in the urban-fringe area. Table 9 shows the population distribution in the urbanized areas of the U. S. by population groups.

Density of population in the total urbanized area, in the Central Cities and in the urban-fringe are as shown in Table 10. The density of urbanized areas decreases as the size of urbanized areas decrease. A factor of considerable significance in the cost of financing water service in the urban-fronge area is indictted by the comparative densities of the urban-fringe to the Central Cities. In general, densities in the urban-fringe are, in all

TABLE 9

POPULATION DISTRIBUTION IN URBANIZED AREAS OF THE U.S.

Population Group	Population Urbanized Area	Population Central Cities	Population Urban Fringe	% Population Central City	% Population[1] Urban Fringe
Over 1 million	38,811,000	24,300,000	13,510,000	63	37
500,000 to 1 million	8,745,000	5,563,000	2,059,000	64	26
200,000 to 500,000	11,152,000	9,190,000	2,812,000	82	18
100,000 to 200,000	8,364,000	6,762,000	2,068,000	81	19
50,000 to 100,000	3,115,000	2,511,000	397,000	84	16
All Areas	69,250,000	48,400,000	20,800,000	70	30

[1] Percentages have been rounded to add to 100 percent. Errors are due to other roundings in additions of populations.

Data from U. S. Census, 1950.

TABLE 10

POPULATION DENSITY PER SQUARE MILE URBANIZED AREAS OF THE U.S.[1]

Population Group	Total Urbanized Area	Central City	Urban-Fringe	Ratio Urban-Fringe to Central City Percent
Over 1 million	7254	13867	3905	28
500,000 to 1 million	4514	6053	2629	42
250,000 to 500,000[2]	4422	5876	2496	43
100,000 to 250,000	3893	4998	2246	45
50,000 to 100,000	3790	4465	1968	44
All Areas	5438	7788	3200	41

[1] From Population Growth in Metropolitan Areas, 1900-1950, Donald J. Bogue, page 50.

[2] The standard interval developed for other tables in this study was 200,000 to 500,000. This table was developed by Bogue and is sufficiently close for practical comparisons to other tables provided herein.

population groups except the largest (over 1 million size) between 42 and 45 percent of Central City densities. For the largest population group the urban-fringe density is only 28 percent of the Central City density.

Table 11 shows the location of the population served by Central City water supply systems. While the population of all Central Cities in Urbanized Areas is nearly 50 million, the water supplies of these cities serve a population of nearly 60 million. This population accounts for 85 percent of the total urbanized area population. For all population groups, over 50 percent of the urban fringe population is served by central water supply systems. Thus, to a large degree, the adequacy of water service in the urban-fringe area depends on the adequacy of Central City supplies.

Although Table 12 relates to the number of local governmental units in Standard Metropolitan Areas, it is presented in order to indicate the order of magnitude of the potential complexity of political organization in present metropolitan areas. While municipalities represent the largest number of local governmental units, the significance of township and county governments is increasing. This is due primarily to the continuing larger growth of the unincorporated parts of metropolitan areas.

TABLE 11

POPULATION SERVED BY CENTRAL WATER SUPPLY SYSTEMS

Population Group	Urbanized Area Pop.	Pop. Central Cities	Pop.Served By Central City Water Systems	% Urbanized Area Pop. Served by Central City Water System	Pop. Urban Fringe	Urban Fringe Pop. Served by Central City Water Supply	% Urban-Fringe Pop. Served by Central Water Supply System
Over One Million	38,811,000	24,300,000	28,790,000	74	13,510,000	4,490,000	33
500,000-1 Million	8,745,000	5,563,000	7,823,000	89	2,059,000	2,260,000	110[1]
200,000 - 500,000	11,152,000	9,190,000	10,988,000	98	2,812,000	1,798,000	64
100,000 - 200,000	8,364,000	6,762,000	8,101,000	97	2,068,000	1,339,000	65
50,000 - 100,000	3,115,000	2,511,000	3,310,000	106[1]	604,000	799,000	132[1]
All Areas	69,200,000	48,400,000	59,012,000	85.4	20,800,000	10,690,000	51

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[1] Probable due to water supply systems serving area outside of census-defined urbanized area.

Data from U. S. Census, 1950, and U. S. Public Health Service Survey of Municipal Water Supply Facilities, 1954.

TABLE 12

NUMBER OF LOCAL GOVERNMENTAL UNITS IN STANDARD METROPOLITAN AREAS

Population Group (S.M.A.'s)	Total (All Units)	Counties-Townships-Municipalities Only		
		Counties	Townships	Municipalities
Over 1 million	3386	30	465	748
500,000 - 1 million	2628	37	346	694
250,000 - 500,000	1800	32	108	364
100,000 - 250,000	3613	66	728	606
Under 100,000	4783	91	681	752
TOTAL	16210	256	2328	3164

Data from Municipal Yearbook, 1955, International City Managers Association.

Industrialization. Industrial production of the Nation has expanded over 800 percent between 1900-1960. Well over half of the increase occurred from 1950 to 1955. The Nation's Gross National Product (GNP) has risen from about 60 billion in 1900 to over 500 billion in 1960 (at 1958 prices). Annual average growth of GNP from 1900 to 1955-57 has been 3.2 percent. While population, civilian labor force and civilian employment have grown at average annual rates of 1.4, 1.6, and 1.6 percent respectively for the period, average weekly hours of work have declined 0.7 percent on the average per year. (91)

The industrial relationship to water is shown in the 1954 report of the Bureau of the Census on industrial water use (92) It is estimated that the industries surveyed in that report represent in excess of 90 percent of all industrial water use. Six of the industrial classes, representing 42 percent of employees and 65 percent of the establishments surveyed, used 91 percent of the total water used by all industry. These data are shown in Table 13.

TABLE 13

MAJOR WATER-USING INDUSTRIES

SIC Code	Name	Employees (1000's)	Establishments	Total Water Used Billions Gallon/Yr.
20	Food and Kindred Products	660	2,614	1,248
22	Textiles	463	778	307
26	Pulp, Paper, Paperboard	252	867	4,129
28	Chemicals	460	1,162	5,004
29	Petroleum and Coal Products	185	376	4,515
33	Primary Metals	877	865	4,654
		2,897	6,662	19,857

Table 14 illustrates the growth of several of the individual industries within these six industrial groups for the period of World War II and the post-war period.

TABLE 14

CHANGES IN RATED CAPACITY IN SELECTED INDUSTRIES
1940-45 and 1945-50 (45, pp. 826-827)

Industry	Unit	Capacity (as of Jan. 1) 1940	1945	1950	%age Increase 1940-45	1945-50
Wood Pulp	1000' tons	10,421	11,994	16,167	+15.1	+ 34.8
Paperboard	1000' tons	7,531	9,900	11,762	+31.4	+ 18.8
Rayon and Acetate Fiber	1000' tons	270	446	625	+65.2	+ 40.1
Crude Oil Refining	Million bbls	1,687	1,935	2,444	+14.7	+ 26.3
Methanol	1000 gallons	73,500	82,500	157,000	+12.2	+ 90.3
Ethylene Oxide	Tons	74,000	100,500	220,000	+35.8	+118.9
Synthetic Nitrogen	1000 tons	625	1,028	1,639	+64.5	+ 59.4
Synthetic Rubber	Tons	11,200	932,300	1,002,400	+82.24	+ 7.5

A further note on growth during the period is shown by the distribution of factory workers in the United States for the years 1900, 1919, and 1947. Data for several of the more important water-using industries are included in Table 15.

TABLE 15

INDUSTRY GROUPS: DISTRIBUTION OF FACTORY WORKERS
IN THE UNITED STATES 1900-1947 (20, p. 1014)

Industry	Number in 1000's 1900	1919	1947	Percent 1900	1919	1947
Food and Kindred Products	377	740	1,442	7.9	8.1	10.1
Textiles, Apparel and Related Products	1,030	1,611	2,315	21.7	17.7	16.2
Paper, Printing and Publishing	298	510	1,165	6.3	5.6	8.1
Chemicals and Allied Products	102	427	1,103	2.1	4.7	7.7

Industrialization and associated technology have made great gains since 1900. While questions are raised with regard to the meaning and importance of rates of growth between the United States and other countries, notably Russia, there is little question that, in terms of gross productive capacity, the United States stands at the apex of world industrial production.

Technologic advances have had a significant impact on the water resource. Progress in food preparation, synthetics, chemical methods, internal combustion engines and their use in trucks, cars and airplanes, paper and printing machines, plastics and other developments too numerous to mention have created problems in both supply, waste disposal and location. (45, Ch. 24)

Up to 1950, the collection of information about water use in industry lagged far behind the collection of other water data. In 1950, the National Association of Manufacturers, jointly with the Conservation Foundation, published their study of water in industry. (104) While the study was inadequate to the needs, it stimulated action aimed at improved data collection in this water resource area.

Early in 1951, the Division of Water Pollution Control of the U. S. Public Health Service initiated a letter to the President's Materials Policy Commission suggesting that water be considered in the Commission's studies because of its importance as an industrial raw material. Further conferences, resulting partly from this letter, with staff members of the Materials Policy Commission, U. S. Geological Survey, and U. S. Bureau of the Census, confirmed the desirability of including water in the Commission's study.[1] (105)

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[1] The two representatives from the Division of Water Pollution Control of the U. S. Public Health Service attending this meeting were Mr. Leonard B. Dworsky and Mr. A. H. Wieters.

Studies by the Materials Policy Commission gave further emphasis to the inadequacy of data about how industry used water. In continuing meetings with the U. S. Bureau of the Census, the problem was further defined and in 1953 the first information on water use in industry collected by the Bureau of the Census was made available in the 1953 Annual Survey of Manufacturers.[1] The response to this effort was so satisfactory that the Census Bureau continued its interest in the collection of water use in industry, and an expanded program was undertaken in the 1954 Census of Manufacturers. These results, briefly presented previously, were again extended in the Census of Manufacturers of 1958 (106) and in a supplementary survey of industrial water use in 1959.

An important addition to the 1958 Census of Industrial Water Use is the coding of water use by water resource regions and subdivisions throughout the United States. As a result, the Nation is much better equipped, in viewing the emerging problems of the Sixties and later decades, to understand and assess its industrial water problems.

With more adequate and accurate industrial water use information; with improved statistics on industrial production and with a keener awareness of industrial location problems and their relation to water quantity requirements and water re-use problems; industrial management, as well as government, can plan sufficiently in advance to alleviate industrial water problems through new or adjusted technology. Industrial zoning and improved industrial land use are now capable of being managed on a more intelligent basis as a result of these new data in the field of industrial water.

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[1] The author was a member of the interdepartmental committee established by the Bureau of the Census from 1951 through mid-1955, responsible for advising the Bureau on the type of data and scope of studies to be pursued in this census project.

4. Water Resources Development.

By the time of the Roosevelt Conservation Conferences in 1907, the major pattern of water resource development was discernible. The navigable (encompassing essentially all) waters of the Nation would be developed for navigation purposes where feasible; such developments would be tied in initially with flood control; irrigated agriculture in the western lands would be supported and waters would, in general, be developed for maximum usefulness, including power, as waters flowed to the sea. The organization established to carry out these developments **was** present then and **has** remained essentially the same throughout the period.

Flood control gained momentum following the devastating floods of 1912-1913 and 1916; in an Act of 1917, Congress provided broader authority to the Corps of Engineers to make surveys for flood control and to related navigation and associated developments and water power to such surveys. Cost sharing under this Act required beneficiaries to pay one-half the cost plus contributing rights of way.

The succession of major flood control Acts included the Acts of 1925 and 1927 which initiated the "308" reports; the Act of 1928 which separated flood control from navigation and reduced the local cost sharing to furnishing the right of way; the Act of 1936 which established a new national policy on flood control, "...that investigations and improvements of rivers...and watersheds for flood control purposes are in the interests of the general welfare; that the Federal government should...participate in improvement...for flood control...if the benefits to whomsoever they may accrue are in excess of the estimated costs...."; the Act of 1944 added participation by States through the requirement that project plans be submitted to the Governors for State comment; and the 1948 Act which opened for consideration floods due to winds or tidal effects. (30) (32) (93)

In June, 1955, the Corps of Engineers had under consideration 1,033 flood control projects involving a total cost of about $11 billion. Of these, 349 were completed, costing $1.5 billion; 84 under construction were estimated to cost $4.2 billion and a backlog of 600 authorized projects had a cost estimate of $5.4 billion. (94, p. 181)

By 1960 some of the developments began to pay dividends. Missouri River main stem dams, capable of storing 69 million acre-feet of water now effectively reduce flood crests in the central Missouri to free cities like Omaha from future floods. Components of the Pick-Sloan plan on Missouri tributaries are bottling up floods on such streams as the Republican, Kansas and Platte. The lower Mississippi is benefitting from these upstream storage controls and together with an integrated levee system are capable of storing off the massive damaging floods of the past. The Tennessee system is under control and large parts of the Ohio system are less liable to floods comparable to 1937. Major difficulties result in the tributary stream systems in relatively flat land areas in which storage capabilities are limited. The Columbia lacks about 12 million acre-feet of storage to control floods to 800,000 c.f.s. at The Dalles, Oregon, and about 20 million acre-feet to bring the river to ultimate control at 600,000 c.f.s. at The Dalles. The Canadian-U. S. Treaty of 1961 would provide effectively for this added storage.

Programs in California, Texas, the Southeast and in New England are undergoing rapid study of development. The Arkansas-Red-White system is tending toward effective control with new structures like Norfolk and Bull Shoals in Oklahoma, Arkansas and Southern Missouri.

Despite the great gains, uncontrolled developments in the flood plain are creating uneasiness, leading to studies by States for the development of effective zoning. Studies by White and others (102) at the University of Chicago are creating much interest in this phase of the problem and as alternate measures in lieu of storing flood waters.

Reclamation, essentially a non-Federal water and land resource development activity prior to 1900, was added to the Federal repertoire of programs by the 1902 Reclamation Act. By 1958, Federal programs in the seventeen western States accounted for less than twenty percent of the total irrigation development in the West. From World War II major programs of supplemental irrigation both in the western States and east of the Mississippi began to place added heavy demands on the water resource base. The development of relatively cheap aluminum pipe and efficient anc cheap pumping equipment was responsible for the large, almost revolutionary, flurry of water reorganization studies occurring since 1950 in eastern and midwestern United States.

TABLE 16

IRRIGATION DEVELOPMENT IN THE 17 RECLAMATION STATES[1]
(In acres)

Decade	Non-Federal	Federal	Total	Cumulative Totals
Prior to 1900	6,700,000	450,000	7,150,000	7,150,000
1900 to 1909	3,650,000	850,000	4,500,000	11,650,000
1910 to 1919	2,800,000	1,000,000	3,800,000	15,450,000
1920 to 1929	950,000	500,000	1,450,000	16,900,000
1930 to 1939	900,000	600,000	1,500,000	18,400,000
1940 to 1949	3,000,000	1,450,000	4,450,000	22,850,000
1950 to 1958	5,950,000	1,700,000	7,650,000	30,500,000
TOTAL	23,950,000	6,550,000[2]	30,500,000	30,500,000

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[1] U. S. Senate, Select Committee on National Water Resources, Committee Print No. 14, "Future Needs for Reclamation in the Western States," *Water Resources Activities in the United States*. (Washington, D. C.: Government Printing Office, 1960), p. 5

[2] Does not include all acres for which a supplemental supply was furnished as an assignment between Federal and non-Federal was made for such lands. In 1958 some 6,750,000 acres of land received either a full or supplemental water supply from the Bureau of Reclamation program, about 575,000 acres received water from Bureau of Indian Affairs developments, and a minor amount of acreage received water from other Federal sources.

The reclamation laws, since 1902, have provided an effective framework for the continued development of irrigated agriculture in the western arid lands. The expansion of the western frontier, land settlement and economic growth have provided continued and effective forces encouraging this sectional development and which is often at odds with eastern views of national priorities.

A system of priorities, based upon rigid economic analysis or upon alternative opportunities for producing food and fiber grown on western reclamation projects remains an interesting speculative matter. As a practical and realistic matter, the Nation has and continues to authorize reclamation practices founded on the 1902 Act and supplemented by an acreage restriction of 160 acres, a power policy based upon the creation of hydro-electric power as an incidental element of projects and a policy of granting priority and preference rights to municipal and other public uses of such developed power.

Contrary to Corps of Engineer policy, reclamation programs conform to the laws of the States in which the development occurs. Thus, water rights are sought by the Federal government under State laws as required and organizations to operate, maintain and otherwise provide for the contractual arrangements of the project follow State authorizing legislation.

Future developments envisaged in plans look to the complete utilization of water resources available in the western States largely for agriculture purposes. With this effort is a growing concern for other uses of water. This matter is not yet assured of suitable solution and remains of concern to those viewing an agricultural economy balanced by related industrial development, use of recreational potential and safeguarding of public health and aquatic life as important factors valuable to regional development.

A third major development during this period was the Department of Agriculture's Watershed Protection and Flood Prevention program. The Franklin Roosevelt conservation program stimulated the fight against soil erosion. One phase of that effort was always recognized to lie in the proper control of water as it fell on the watersheds--defined essentially as the area comprising the upland areas of the Nation's water basins. In 1936, the Flood Control Act of that year specified that the Corps of Engineers was to be charged with flood control works on the waterways or main streams. Jurisdiction was given in the Act to the Department of Agriculture to undertake "Federal investigations of watersheds and measures for runoff and water flow retardation and soil erosion prevention on watersheds."[1]

The Assistant Secretary of Agriculture, E. L. Peterson, defined the program's primary purpose "to provide Federal assistance to local units of government in carrying out those soil and water management measures of a community nature that cannot reasonably be accomplished by individual landowners and operators with help provided through other departmental programs of educational, technical, financial, and credit assistance. Public Law 566 provides a mechanism through which may be bridged the gap between the conservation work of farmers and ranchers, and the major projects on our nation's rivers carried out by Federal construction agencies such as the Corps of Engineers and Bureau of Reclamation."[2]

Between 1936 and 1952 Congress authorized the Department of Agriculture to make preliminary investigations on 1,082 watersheds. However, no authorization for actual works of improvement took place until the 1944 Flood Control

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[1] U. S. Congress, 82nd Congress, 2nd Session, The Flood Control Program of the Department of Agriculture. Report to the Committee on Public Works; Subcommittee to study Civil Works. House Committee Print No. 22, December 5, 1952.

[2] U. S. Congress, Hearings on H. R. 8750, An Act to Amend the Watershed Protection and Flood Prevention Act. U. S. Senate, 84th Congress, 2nd Session, July 3, 1956.

Act. By 1951 work on eleven authorized watershed projects had cost over $23 million with an estimated completion cost of $152 million.

By 1954 vigorous action by wide-ranging proponents of watershed programs, led by Congressman Clifford Hope of Kansas, helped pass the Watershed Protection and Flood Prevention Act, Public Law 566, 83rd Congress. The Act freed the Department from the complexities of survey, planning and authorizations and the close relationship to the Corps of Engineers program of flood control. Under this program, geared to program initiation based on local watershed organization and action, Agriculture moved forward into a new and vigorous phase of holding the water where it falls; of preventing floods and subsequent damages to the land.

By 1956 the program sought and received Congressional approval to broaden the base of functional elements to be served. Thus, watershed programs were to permit the inclusion of storage in flood prevention structures for other purposes as irrigation, municipal water supply, and low flow control to provide water for stock purposes, maintain fish and wildlife and for pollution abatement.

The addition of the watershed program has provided those dedicated to this aspect of water and land conservation with a workable device. It has not, however, quelled arguments between proponents of upstream flood control versus downstream control measures. It has increased the problem confronting the Federal government in matters concerning cost-benefit relationships; in efforts to unify Federal policies for comparable work; in the development and analysis of hydrologic data as applied to long range planning and with respect to the ability to undertake long range planning due to the inability to determine project initiation when under local control.